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THE ELECTRIC LIGHT IN LIGHTHOUSES.

THE history of the adoption of the electric light in lighthouses dates back over 30 years, and although the use of the light for the purpose has by no means become general, it is a recognised method of illumination, and we occasionally hear of its employment being extended. Opinions still differ as to its merit compared with oil or gas, and as in every other question, there is much to be said for and against each method of illumination. Prof. Tyndall, who for some years past had been the adviser of the Trinity Board, and whose manful advocacy of the inventions of Mr. Wigham against Sir James Douglass in the matter of gas *versus* oil illumination is well known, has recently contributed two articles to the *Fortnightly Review* on "A Story of the Lighthouses." In the second of these articles the use of the electric light is discussed. Prof. Tyndall takes a decidedly adverse view of its merits, and we think not without reason. No one ventures to question the general brilliancy of the electric as compared with other lights, but the penetrating power of the former under certain conditions becomes enormously reduced, and it is under these very conditions that it is most required to be as effective as possible. Opinions are unanimous as to the power of the electric light in fine weather when it is used as an illuminant for lighthouses, though it is stated that it is misleading as regards distance. In fog, however, when the light is most wanted, its power is woefully diminished; in fact, it cannot penetrate, a defect due to the smallness of the focus from which the illuminating beams radiate. Gas or oil burners, on the contrary, owing to the large light surface which they expose, can be seen, in a fog, at a comparatively great distance.

According to Prof. Tyndall, the "unvarying testimony of those who have been consulted regarding the performance of the St. Catherine's light (one of the latest erected)—including even those who describe it in clear weather as 'magnificent'—is that in fog it is 'worthless.'" As regards ease of manipulation, we think the electric light would bear off the palm, and there is no reason to think that it is unreliable, although on one occasion when the St. Catherine's light was watched, between the hours of 6.15 and 9.45, seventeen extinctions, lasting in one case as long as 78 seconds, were observed. Such extinctions as these could only be due to a faulty lamp, we imagine, and not to any defect in the carbons employed. If, however, we grant that on the score of ease of manipulation and reliability the electric light stands foremost, the fact that its penetrating power in a fog, when the light is most wanted, is but feeble, is quite sufficient to condemn it. At the same time, however, the fact that since the first introduction of the light for lighthouse purposes, now more than 30 years ago, its adoption has been extending, requires explanation; for if the obscuring power of a fog is as great as it is stated to be, it must have condemned the use of electricity many years ago. Possibly, however, small as the penetrating power of the electric light is, it may still have been greater than that of the best oil lamps employed up to within the last few years, and surely it would not be a matter of very great difficulty to devise a sub-divided arc, so as to enlarge the focal area? Electrical engineers might with advantage try to effect improvements in electric lamps for lighthouses, which should only stop short when Professor Tyndall declares himself satisfied with the result. We cannot imagine for one moment that any trifling economy in the use of other illuminants would stop the way of the arc light when the saving of human life is the object sought: therefore we believe that electricity will be universally employed for lighthouse purposes when arrangements have been made to give it increased penetrating power in bad weather.

THE EDISON AND BRUSH APPEAL.

As will be seen from our other columns, judgment has now been given in the appeal case which the Edison Company brought against the prior decision of Mr. Justice Kay with regard to the validity of the Edison patent for incandescent lamps.

After we do not know how many weeks of solemn consideration, we certainly expected something less ponderously superficial than the three judgments delivered last Monday.

The judges have never yet got rid of the idea that Edison's object was to make practical incandescent lamps, and not merely to make practical incandescent lamps for parallel lighting. They are also saturated with the notion that because incandescent lamps came into use after Edison's patent, they resulted from his patent. Moreover, they do not seem to think anyone but Edison was working at lamps in 1879.

The crowning feature of all is the idea that by using a long thin carbon instead of a short thick one, a lamp was improved *per se*, that is apart from the consideration of large or small leads.

Of course, the whole matter lies in a nutshell. Edison's name is a sort of fetish, and the public, including the judges, have come to regard Edison as a sort of phenomenal inventor, and when he is advocated by such an awe-inspiring blunderbuss as the Attorney-General seems to be, cool reason has very little chance of success.

As frequently urged in these columns, the trial of patent actions by the present courts is an absurdity, and must in some cases lead to injustice. The litigants have to some extent the remedy in their own hands, as under the new Act they have the power of demanding that assessors shall be called in. It may be interesting, though not instructive, to glance at the judgments separately.

Lord Justice Cotton first held that the utility of Edison's "invention" was established by his sending over lamps to Hopkinson in March, 1880, which were run publicly. This is Hopkinson's apocryphal lamp cropped up again. Edison's invention refers to making lamps to run in parallel with small leads, and, much as we value Dr. Hopkinson's ability, we doubt whether he could run one apocryphal lamp in parallel on this side of the Channel, at least not publicly. Dr. Hopkinson says nothing about running his apocryphal lamp at all in his evidence, so the learned judge no doubt dreamt it during some of counsel's speeches. Perhaps he confused Dr. Hopkinson with Dr. Fleming, and mixed the apocryphal lamp with some made under subsequent patents.

The next point is whether Swan's lamp was an anticipation. The distinction that Swan's lamp had its carbon shaped after carbonisation had vanished, as it was what was delicately called a "mistake" on the part of the Edison people. Swan's lamp was taken as a failure because Swan and Stearn thought it was. But would Swan and Stearn have considered Edison's apocryphal lamp a success? Would not one of Swan's lamps run in series last infinitely longer than Edison's apocryphal lamp in parallel? The difference of thickness of carbon is in no way essential. If one wants a little water at a high pressure instead of a lot at a low pressure, one uses a small pipe.

Lane-Fox's work is ignored altogether. Lane-Fox says if it is required to work in parallel a long thin conductor is needed. Swan found carbon would do when short and thick, but that it is better to make it long and thin according to Lane-Fox's instructions if parallel lighting is wanted, and Edison says we ought to make a long thin thing of carbon.

As to instructions, it was held that the lamps made by the Edison people for the Woodhouse and Rawson case were commercial. It has come to our knowledge, or at least we have been told, that these were not made by rolling the tar-putty at all, but that the putty was squirted by means of a cylinder and plunger compressed in a bench vice. We hope we were falsely informed, for if this was so, it would not have been honourable to have put them in as made according to Edison's specification. It would have been a "mistake." As to the kneading of the tar-putty, it will be remembered that the Edison people had the Whitsuntide recess to find out how to make tar-putty threads. We also think it reflects gravely on the witnesses who said that an efficiency of 15 watts per candle was commercial. Such points as these are difficult for judges or counsel to understand, and it is certainly not the case that 15 watts per candle was a commercial efficiency even in 1879. Lane-Fox's platinum lamps would run higher than that, and it is not of commercial utility to introduce goods worse than those already available. We expect unbiassed opinion even from expert witnesses. Similarly, statements as to efficiency of lamps whose life is not given are wilfully misleading.

Lord Justice Lindley pointed out that a specification must not only show clearly what the invention is, but how to carry it out. The invention is clear enough; it is a filament. What is a filament? Nobody knows, not even the Court of Appeal. A filament was recently something shaped before carbonisation, now it is anything that will make a lamp work. Everything is really either a filament or a diaphragm. Mr. Edison consists essentially of two stretched circular diaphragms arranged parallel with air between contained by a cylindrical boundary.

Lord Justice Lindley goes on to show how an intelligent workman could find out how to make tar-putty and other filaments, but forgets that a workman of such intelligence could make a lamp equally well from Lane-Fox's specifications, or with the knowledge available in 1879. He goes on to say that if Swan's lamp had worked, it would have been an anticipation; therefore Edison's invention did not consist in making a thin carbon, but in making a workable lamp, and that he did by using, or proposing to use, a thin weak thing instead of a thick strong thing. It is needless to remind our readers that the long thin carbon was only needed to make the lamp fit for parallel lighting, and was inferior as a carbon, taking the lamp by itself.

Lord Justice Bowen practically agreed with the others, and held that Swan's lamp was on the wrong track and useless, and that everything done in lamps was merely improvement of Edison's lamp; in fact, according to the Courts, Swan was a mere pirate.

The case will go to the Lords, for the Anglo-American Brush Corporation has appealed, but it is somewhat doubtful whether they will understand it any better. Whether lamps like the "Sunbeam" or Bernstein's are infringements it is difficult to say. Apparently any lamp that will work is Edison's.

An attempt to get an injunction against the Brush there and then was made, but it failed. The Brush Company had a prior retainer on the Edison Company's counsel, and to defeat this, or partly with that object, the Edison Company sued Holland, and not the Brush Company.

Whether the result of the action will be disastrous to the trade or not now depends very much on the policy pursued by the Edison-Swan Company.

FROM the abridged report of the motor trials instituted by, and carried out under, the auspices of the Society of Arts, readers can judge for themselves as to the merits of the engines employed. It appears certain that a gas engine, which has hitherto been considered more or less omnipotent, will not in future control the market. This, however, is a matter which scarcely calls for regret, for a little wholesome competition will probably make a vast difference, not only in the receipts of the firm, whose engines, like the *Daily Telegraph*, have "the largest circulation in the world," but also in their methods of treating their clients.

THE worthy secretary of the Elieson Electric Company informs us that in consequence of the impossibility of providing the further capital necessary for carrying on the undertaking on an adequate scale, it has been decided to offer the whole of the property for public competition at an early date. It is proposed so to arrange the sale as to admit of the English patents, together with running rights, and the new station in the Romford Road, and the colonial and foreign patents being offered separately. It would be interesting to know what steps have been taken to procure the necessary cash to keep the scheme going, for surely this need not have been either a difficult or lengthy matter, and the events which have led to the final collapse of a once promising company ought to be made known. If time allowed, perhaps the Sprague or Daft people might step in and save the Elieson system from oblivion, especially since, as Mr. Thos. P. Gower truly states, so much has been done to demonstrate its practicability. For this very reason we may well ask why the directors have now found it necessary to abandon electric traction, when on the very eve of commercial success.

"AMERICAN smartness" is not confined to any one subject: it pervades everything in the universe, and several of our estimable contemporaries on the other side have waxed wroth with us because we have on several occasions made use of a term which they consider objectionable. They, however, are perfectly well aware in which sense we have employed the expression, and we have no necessity to urge upon our trans-Atlantic friends the fact that in no quarter is American smartness and enterprise of the right kind more appreciated than by ourselves. We have just discovered one more example of the "other kind" which cannot be left without protest. In a technical journal called *Practical Electricity*, which has, however, only reached its sixth number and which hails from the hub of the universe, we find an article on "Alkaline Accumulators" which Mr. P. Bedford Elwell sent to us and our English contemporaries. To all intents and purposes this reads like an editorial in Boston technical literature. A paper which Mr. Legh S. Powell wrote specially for this journal on "Electric Lighting of Domestic Fires," is also coolly published in full without any acknowledgment, and one of our leaderettes of a short time since also shares the same fate. Owing to the short existence of *Practical Electricity* we will try to imagine that its editor has not yet become acquainted with the etiquette of journalism, for although an omission of the source of one's information may occur at times through an unintentional error, three glaring examples in one number of a journal makes it quite without the pale of possibility to believe that such mistakes were made unwittingly.

WE notice in the issue of the New York *Electrical World* of February 2nd a letter addressed to the editor of that journal, from the pen of Capt. S. Trott, in which the well-known commander of the ss. *Minia* disclaims any participation in Judge Weatherbee's contribution (see ELECTRICAL REVIEW of February 15th) to the study of submarine telegraphy. To what extent Capt. Trott's anticipation as regards the successful future of unarmoured cables may be correct, we know not, but we maintain that the "work already accomplished," which consisted in the laying of some miles of hemp-covered cable, throws no fresh light on the subject, for it has never been a matter of dispute that such cables could be laid. The only deduction to be drawn from the experiment, so far as it has gone, is that a cable company was willing to invest capital in a trial of this particular form of cable. Some time must elapse before the question of durability is solved, and a repair must be effected before we can assume that an unarmoured type of cable will resist the rough treatment it must experience in grappling work. Capt. Trott says that his hemp-covered cable has "all the strength required for water of the greatest depths, even including the Pacific Ocean, with its 4,500 fathoms." Now, whether the gentleman we quote is a believer in that bugbear of 4,500 fathoms held up to frighten naughty people who advocate a Pacific cable we are unable to say; but it is evident to any one who has even cursorily examined charts of the Pacific that there is as much reason to mention these great depths in connection with a cable between Canada and Australasia as there would be in quoting the deep water (4,561 fathoms) to the north of Puerto Rico, in connection with one of the Anglo-American Company's cables. The degree in which self-induction is aggravated by the presence of an iron sheathing, as in the case of an Atlantic cable, is a question which we do not think has yet been decided. Some increased effect will no doubt be observed, but whether the difference in this respect between a sheathed and an unarmoured cable would, under the circumstances, be sufficient in itself to render the adoption of the unarmoured type of great advantage is a point still to be determined.

THE device of Mr. Bathurst, which was explained in our Notes of last week, seems really deserving of close attention from contracting electrical engineers. It is often the case that a weak spot is to be found in one or more of the little details which together go to make up a complete electric light installation, and Mr. Bathurst has apparently overcome one of the chances of mishap which has hitherto existed.

ON SECONDARY CURRENTS AND A NEW SECONDARY BATTERY.*

By JOHN PARNELL, M.A., F.R.A.S.

1. As far as I am aware, no account has hitherto been published of the employment of alkaline solutions in the development of secondary currents; the investigation described in this paper was therefore undertaken for the purpose of ascertaining whether by this means effects more powerful than those previously observed could be obtained; and the results appear to be satisfactory.

2. The apparatus employed consisted of:—

(*a*) A Daniell cell as an exciting couple, connected with an ordinary commutator.

(*b*) The experimental secondary couple, which was formed of two plates of the same metal, one of which was folded round the other in a U form. These two plates were separated from one another by pieces of ebonite at a distance apart of about 2 millims. The available surface of the inner plate was nearly 14 square centimetres.

(*c*) A Morse key, by which one pole of the secondary couple could be rapidly detached from the exciting cell and thrown into communication with

(*d*) A Thomson's astatic reflecting galvanometer, whose internal resistance was rather less than ·6 B. A. unit. The deflections were read off in the usual manner, on a scale which was so graduated that 300 divisions occupied a space of 19 centims. The image of the slit appeared as a band of light 4 millims. broad, the position of one edge of which, sharply defined, gave the index reading. By using a lens sufficiently large for the scale to be viewed by both eyes at once, the error of observation did not exceed ·5 of one division, or, in the deflections generally obtained, ·3 per cent. of each reading. Attached to the galvanometer was a shunt, by which 9 per cent. or 99 per cent. of the current could be diverted at pleasure from the galvanometer coils. The directing magnetic bar was placed at the top of its support, and with the same orientation as the upper needle.

The index readings taken were in all cases those corresponding to the extreme swing of the galvanometer needle.

(*e*) A set of resistance coils from 1 up to 13,000 B. A. units.

(*f*) A key, by means of which the current from the Daniell cell could from time to time be sent to the galvanometer through the same resistance coils as the secondary current.

(*g*) Other apparatus, mentioned in the account of its employment.

3. The connections are shown in the accompanying figure (fig. 1), where A is the galvanometer, B the shunt, C the commutator, D the Daniell cell (of which P and N are the poles), M the Morse key (of which *d* is the anvil on which the spring presses the lever), R the resistance coils, S the secondary couple (of which *a* and *b* are the plates), and Z the key (§ 2 *f*). When the commutator is so turned that *a* is connected with P, N is in metallic communication with *b* through the lever of the Morse key, and the secondary couple is being excited; but on depressing the lever, *b* is shunted from N to the galvanometer, and the secondary circuit is completed through the resistance coils to *a*. When the commutator is turned off, by depressing the key, Z, the Daniell current is sent through the resistance coils to the galvanometer.

FIG. 1.

4. The *modus operandi* will now be quite apparent: the index having been carefully adjusted to zero, the commutator was turned so as to excite the secondary couple, and at the expiration of 20 seconds, the interval having been taken by the ticks of a clock beating dead seconds, the Morse key was depressed, the index reading observed, the commutator turned off, and a short circuit made to exhaust the secondary couple before another experiment was made. This process was repeated in each case till five results had been obtained, the mean of which was recorded. After the first, third, and fifth experiment the deflection of the galvanometer by the Daniell cell was observed and the mean of these results noted. The ratio of the secondary to the Daniell mean, multiplied by 10^3, is the figure of merit recorded in this paper, and gives the value of the couple under examination, that of the Daniell cell being 1,000. During a set of five consecutive experiments, the index-reading due to the Daniell cell never differed from the mean by more than one division of the scale. The following instance of a set of experiments taken at random, from the many hundreds which have been made on this subject, will give a fair notion of the results obtained (Table I.):—

TABLE I.

No. of experiment.	Secondary readings.	Daniell readings.	Ratio of means × 10^3 or figure of merit.
1	157	176	
2	158		
3	157	176	
4	158		
5	157	175	
Means ...	157·4	175·6	896

Unless otherwise mentioned, throughout the whole course of the experiments herein described 9 per cent. of the currents was shunted from the galvanometer; and the resistance employed was 7,000 B.A. units, in comparison with which all the other external resistance, and *à fortiori* any accidental variations in it, vanished.

5. Some preliminary experiments showed that copper plates in a solution of carbonate of sodium formed a powerful secondary combination; and, to see what advantage it possessed relatively to known secondary arrangements, it was compared with platinum, palladium, and lead in dilute sulphuric acid (one part acid, six parts water). The specific gravity of the solution of the carbonate, as well as of all the other alkaline solutions mentioned in this paper was 1,050, that of water being 1,000. The following results were obtained*:—

TABLE II.

	Figures of merit.
Daniell	1,000
Cu sod. carb.	853
Pt dil. sulph. ac.	772
Pd dil. sulph. ac.	732
Pb dil. sulph. ac.	306

6. When the copper plates were clean and polished, the figure of merit was far below that mentioned above; but the more frequently the plates were excited, and the more corroded they became, the stronger was the current produced. Copper plate as it comes from the rollers will, under the influence of powerful electric currents, very quickly acquire a condition of surface favourable to the development of secondary currents; and that condition, once acquired, is apparently always retained. Indeed the highest result obtained with any

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* From the *Philosophical Magazine* for January, 1870.

* In this and all subsequent tables the highest uniform results given by good experiments are recorded, as all the errors of operation, whether instrumental or functional, tended to diminish rather than to increase the figures of merit.

experimental couple was given by a pair of copper plates whose surfaces appeared to be completely covered with crystals of carbonate of copper, the solution in which they had been placed having evaporated.

7. Other alkaline solutions were then tried, viz., of the hydrates of sodium and potassium and the carbonate of potassium. The results obtained by using copper, platinum, and palladium in solutions of the carbonates and hydrates of sodium and potassium are given in Table III. :—

TABLE III.

	Sod. carb.	Pot. carb.	Sod. hyd.	Pot. hyd.
Copper	853	883	867	896
Platinum ...	831	827	772	756
Palladium ...	740	758	777	645

8. Lead, silver, zinc, brass, and tin plate were tried in these same solutions, but they all (with the exception of brass in carbonate of potassium, which had a figure of merit 820) gave results far inferior to those recorded in Table III. The diacid carbonates were found to be far less energetic than the neutral carbonates. Increasing the specific gravity of the sod.-carb. solution slightly raises the figure of merit, but not to an extent sufficient to counterbalance the disadvantage of a more rapid efflorescence on the plates. A very few drops of a solution of ammonia added to the sod. carb. solution reduced its power by 75 per cent. A prolongation of the time of excitation caused an augmentation of the figure of merit, which, when that time is a variable, becomes a function of its reciprocal; and as copper in sod. carb. attained very nearly its maximum force after twenty seconds' excitation, whereas all other combinations required a much longer time, it is not thought necessary to burden this paper with tables of the results obtained.

9. Although, as has been before stated (§ 4), by the mode of manipulation adopted we practically eliminate all external resistance (other than the resistance coils) and their variations from consideration as regards the galvanometer circuit, yet the variation of the internal resistance of the Daniell cell, which affected the intensity of the exciting current, is of serious importance, and was, no doubt, one cause of the variations which appeared in the readings obtained on different days during the course of this investigation, although on the same day the results were very accordant. On this account the experiments were continued from day to day till a large number of results had been obtained; and from these it appears that the relative powers of the metals and solutions described in the Tables to this paper were always maintained.

10. There is another point to which attention was directed, which was this—that the secondary couples did not lose their power with the same rapidity, either during discharge or spontaneously; and as in the practical application of secondary batteries, as well as in their scientific aspect, the persistence of the current is of importance, experiments were undertaken to determine the rate of decadence of the powers of certain couples; and some of the results are recorded in Table IV. :—

TABLE IV.

Seconds rest.		Cu sod. carb.		Cu pot. hyd.		Pt dil. sulph. ac.
20	...	12	...	5	...	30
40	...	17	...	8·5	...	43

In these experiments, after the Daniell cell had been cut off from the secondary couple, an interval of 20 or 40 seconds was allowed to elapse before contact was made with the galvanometer, and in the above Table IV. we have the percentages of loss sustained by the secondary couples during those intervals. We see that copper in a solution of hydrate of potassium lost only 8·5 per cent. of its force during 40 seconds, whereas platinum in dil. sulph. ac. lost in the same time 43 per cent.

11. To test the permanency of the secondary current during discharge, the resistance was reduced to 700 B.A. units, employing the 99 per cent. shunt. In the following Table V. we have the figures of merit of copper in sod. carb. and platinum in dil. sulp. ac. with 7,000 units and 9 per cent. shunt, and 700 units and 99 per cent. shunt respectively :—

TABLE V.

Resistance	7000.	700.
Copper	853	821
Platinum	772	570

From this we see that, on diminishing the resistance of the secondary circuit by more than 6,000 B.A. units, the platinum couple lost its force during the time (about three seconds) of the swing of the galvanometer needles much more rapidly than the copper couple.

12. Copper[*] plates were tried in a solution of the impure carbonate of sodium known in commerce as "soda;" and not only did they rise more quickly to their full power, but the maximum was far greater than that with the pure substance, giving a figure of merit 920—a value so high that, if it represented even the whole of the electromotive force generated in the secondary couple, we might be inclined to think that further experiments in this direction could lead to no better result; but a portion of that force was lost during the swing of the galvanometer needles. It will be seen further on that, when working on a larger scale and with a more accurate method of measuring the electromotive force, we can obtain a figure of merit higher even than that just mentioned.

13. The force developed with the copper "soda" couple for periods of excitation less than 20 seconds is shown in Table VI., where the power of the couple after 20 seconds is represented by 100 :—

TABLE VI.

Period of excitation, in seconds.		Force of couple.
2	... ...	75
4	... ...	83
6	... ...	88
8	... ...	91
10	... ...	94
16	... ...	98
20	... ...	100

so that after 10 seconds of excitation the force attained is within about 6 per cent. of the maximum.

14. The interposition of flannel between the plates of the experimental copper-"soda" couple having shown no tendency to diminish its force,[†] a 40-cell secondary battery was constructed, each couple of which consisted of two plates of copper separated by flannel, each plate presenting an effective surface of 516 square centims., and was immersed in a solution of "soda," spec. grav. 1,050. This battery was arranged in 10 sets of four cells each, and each set was connected in series. A commutator was devised for the purpose of charging this battery as 10 compound cells, and discharging it as 40 cells in series.

15. The current from this battery had for a secondary current considerable duration; after one excitation, repeated deflagrations could be obtained with tin or platinum foil; with the latter of the thickness of ·1 millim. a hole was pierced 4 millims. in diameter, the edges of which were fused. Its electromotive force was measured by a Thomson's portable electrometer, and the results are given in Table VII.

TABLE VII.

		Potential.
Five Grove cells	... ...	3
Forty secondary cells	... ...	19
" " and five Grove cells	... ...	22

(In order to throw the Grove battery into the same circuit and in the same direction as the secondary battery, a very simple and obvious addition was made to the connections.) These results were repeatedly obtained without any variation, and are in complete accord. The electromotive force, therefore, of the 40 cells was equal to that of 31·6 Grove cells.

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[*] In this, as in all other alkaline solutions, copper was found to be far superior to every other metal with which experiments were made.

[†] Although I could not, after repeated excitations during many months, observe any deterioration in the condition of the flannel, yet no doubt an electrolytic action had taken place, as a purple dyeing substance was produced, which gave a deep violet tint to the flannel and solution, the latter becoming fluorescent. We shall see further on that when a powerful exciting battery is employed, flannel is not suited to the purpose required.

16. After some months' inaction this battery had seriously declined in power; and on examination it was found that the flannel was almost entirely destroyed. The couples were therefore reconstructed, and on a smaller scale. Each of the copper plates in each pair now made exposed an effective surface of 108 square centims., and was separated from the other by pieces of ebonite at a distance of rather less than 2 millims. On charging 40 of these couples by five Grove cells, and connecting the terminals with the electrometer, the following results were obtained :—

TABLE VIII.

	Potential.	Equivalent number of Grove cells.
Five Grove cells	3 ...	5
Forty secondary cells ...	23 ...	38·3
Do. with five Grove cells...	26 ...	43·3

Now, since the electromotive force of the 40 secondary cells in series is represented by 23, that of five cells will be 2·875; and as the force of the five Grove cells is expressed by 3, we see that the force of each set of five secondary couples is 95·83, or nearly 96 per cent. of that of the exciting battery, a result which can scarcely be greatly surpassed. An experiment was made to test the usefulness of this form of battery for telegraphic purposes. The discharge was sent through 19,000 B. A. units, or more than twice the resistance of the Atlantic cable, and was received at an indicator such as is employed only to test the continuity of telegraph wires, and which is a comparatively coarse instrument. The deflection of the needle when contact was first made was 35°, and at the end of one minute, the contact having been continued during that time, 20°; whereas the five Grove cells could of themselves produce but a very feeble motion of the needle, of 2° or 3° only. An excitation of five seconds' duration appeared to completely restore to the secondary battery its original power.

17. There is one disadvantage attending the use of the carbonate of sodium solution in secondary batteries, viz., the efflorescence on the plates and cells. Many different substances, such as shellac in alcohol, oil, lard, and black enamel varnish, have been tried, but sooner or later the crystals of the carbonate creep either under or over the varnish. Perhaps hot paraffin poured into the top of the cells when the battery is first made, and, after cooling, a hole bored to allow of the escape of any gas generated, might answer the purpose of checking the efflorescence.

Hadham House, Upper Clapton,
December 13*th*, 1869.

INSULATION MEASUREMENTS AT THE NEW PALACE THEATRE AT VIENNA.

By DR. A. VON WALTENHOFEN.

(*Concluded from page* 182.)

WE have made mention of three methods of measurement, those with the Weinhold mirror-galvanometer respectively without and with a by-circuit, and with the induction apparatus, and a vertical galvanometer. This third method was only exceptionally applied, especially in badly insulated conductors, which in any case required to be repaired, and where there was consequently no need to determine the exact amount of their deficiency.

The frequent occurrence of defective conductors, notwithstanding all the care which the engineers had bestowed upon the materials and the work, is not surprising if we consider that here many conductors were rejected, which in other installations would have been accepted as satisfactory, and that a great part of the electric arrangements were being executed whilst hundreds of workmen were still engaged on the premises and whilst parts of the walls were still damp.

In addition to the three above-mentioned methods of measurement, a fourth has been applied, with which I only became acquainted as these measurements were drawing to a close. This is the procedure described by F. Uppenborn in the *Centralblatt für Elektrotecknik* (1888, Part 22), in which a torsion-galvanometer is used along with a measuring battery, having the same polar tension as the system under examination.

To this process I shall refer below.

The conductors are almost all partly lead cables from the Chaudoir (Vienna) works and partly caoutchouc cables from the London Electric Wire Company or from the works of Franz Tobisch. The copper wires were all tinned.

At the beginning of the measurements an engineer of the I. C. G. A. delivered to us a list of the conductors which were on that day complete, and at our disposal. In case of need a duplicate list was prepared, so that one copy might lie in the measuring room, and another be taken to the point of connection. Hereupon, in order to effect the galvanometric and telephonic connection between the measuring room and the point of junction, the measuring lead and the two telephonic leads, together with the portable telephone and its tripod stand, were conveyed to the place where the conductors noted for examination were accessible for measurement.

One of our colleagues, along with an assistant of the Electrotechnical Institute, and, in case of need, with a fitter of the company's, remained at the point of junction to carry out any arrangements signalled from the measuring room, and to signal back its completion. Another assistant in the measuring room noted down the readings and results made by me or by my representative, and calculated at once the resistances which followed. One of us officiated at the telephone in the measuring room.

Before every series of measurements, the measuring lead itself was examined, and the determinations were not begun until it was found in order.

After completion of the day's work the results were communicated to the engineers of the company, the portable apparatus was brought back to the central point, and the measurements obtained were transferred into two copies of the day-book, one of which is left at the Electrotechnical Institute. The lengths of the conductors, as far as ascertained, were entered, as also whether and in what manner the conductors were already connected with lamps. If, *e.g.*, a triple conductor group of the second rank was already fitted with lamps, there resulted for the insulation resistance the same value, whether the measuring lead was attached to the positive, the negative, or the alternative distributive conductors.

The succession of the measurements was as follows :—

Firstly, we measured the distributive connections of the second rank (A_2, fig. 1). Most of the distributive conductors of the second rank were not yet fitted with lamps, and could therefore only be measured singly. At the same time the great chandelier in the auditorium was measured, though it has a special conductor of the first rank, and was already fitted with its 373 lamps.

The above-mentioned distributory conductors were subsequently soldered to the conductors of the first rank (A_1, in fig. 1), which latter were again fixed to the main switchboards destined for connection with the main conductors (A, fig. 1).

Then followed the group measurements, *i.e.*, the measurements of the insulation resistances of the triple and double systems of the first rank, together with connected branches and the lamps, the influence of the switchboards being, of course, taken into account.

Finally, I undertook general measurements of the insulation resistances of both the systems marked as A and B, in fig. 1., in the first place, the whole net of conductors, exclusive of those for the stage; secondly, those of the stage, and, lastly, of all together.

Besides these determinations, the measurements had to be repeated in the case of conductors which had been amended or exchanged, thus raising the entire number of determinations to 600—800.

The measurements, therefore, consist of three categories, executed in order of succession: single measurements, group measurements, and total measurements.

We will first discuss the single measurements.

The insulation of the conductors, excepting such as had been damaged by violence or by moisture, was, in general, excellent. Of the 600 conductors which were measured, the majority had an insulation resistance of several million ohms, many above 100, and some even 400 to 500 megohms.

For the chandelier in the auditorium, which carries 373 lamps and has 250 metres of conductors, the resistance when fitted with lamps is 1·4 megohms. The chain from which the chandelier hangs is also insulated from its body, and shows an insulation resistance of 61 megohms.

It lies in the nature of things that the insulation resistance of complex conductors will always be found smaller than the value calculated from the single determinations, as all the switches and safety appliances unavoidably occasion losses of current. A further decrease of resistance is found when the lamps are introduced into the conductors. Hence we cannot feel surprised at finding in the group measurements much lower resistances than those recognised in the single measurements.

In order to find for the latter an average value, I requested Herr G. Frisch to take out of the day-book of the measurements a large number of instances, and to calculate the average insulation resistance per unit of length. He selected the box conductors, 72 in number, which had been found to be neither the best nor the worst. For these he found an average value of 1·7 megohms per kilometre. This value is reduced to one-tenth, if we pass to systems of conductors fitted with lamps.

We will speak next of group measurements, and finally of the total measurements. For the groups which were more distinctly defined resistances have been found varying from 7,000 to 60,000 ohms, the average being rather more than 40,000 ohms for one of the 34 groups.

Messrs. Frisch and Peukert also undertook to measure the insulation of the switchboards from the earth, taken separately, especially the four connected principal switchboards, which serve to join the distributive conductors of the first rank to the main conducting rails. The resistance was found to be about 60,000 ohms. This is at the same time the upper limit for the insulation resistance of a group.

Observations were also made on the insulating power of the slate slabs used in the leaden switches and of the saturated switchboards. The very low conductivity of these materials had to be taken into account in working with the mirror galvanometer, but it is practically of no importance.

When the single measurements were undertaken the conductors in question had been already secured to the slate slabs in few cases only. If this occurred I caused the conductor to be detached from the slab.

In measuring groups it was not practicable to separate all the conductors from the main switchboard. Passages of currents were capable of detection by a very sensitive mirror galvanometer, even when the accumulators were disconnected. These currents are not only unimportant in practice but they did not interfere with the measurements with the mirror galvanometer.

The same was the case with the connection measurements, in which we employed a less sensitive instrument, the torsion galvanometer.

The total measurements were conducted as follows: As the measuring battery, B, we used a small accumulator battery, B, of 52 elements. In its circuit there was introduced a torsion galvanometer, g (Siemens and Halske), adapted for strong currents, with its resistance box. By means of this the extra resistance, $z = 999$ ohms, was introduced in front of the galvanometer, so that it stood at $G = 1{,}000$ ohms, since the resistance of the instrument itself for strong currents $= g = 1$ ohm. In this manner we obtained a degree of sensitiveness at which an angle of torsion of 1 degree represented 1 volt of tension at the clamps of the extra resistance and of the galvanometer. The prolongation of the conductor, which could be closed or opened by means of the plug, S_1, was applied to one of the three copper rails with which the 94 distributive cables of the first rank were connected, of course after the disconnection of the accumulators. The other pole of the measuring battery was carried to earth. At a and b a bye-circuit was applied which could be closed or interrupted by means of the plug, S_2.

The execution of the Uppenborn method of measurement was as follows:—

In the first place, S_1 was left open and S_2 was closed. The tension, Δ, of the measuring battery (neglecting the resistance of the conducting wires at the terminals of the system, G) effects a deviation of the bell-magnet, which is compensated by the torsion of the angular amount ϕ, in accordance with the equation $\frac{\Delta}{G} = k\,\phi$. If we now open S_2 and close S_1 the insulation resistance, x, is introduced, and involves the angle of torsion, ϕ', according to the equation $\frac{\Delta}{G + x} = k\,\phi'$, where k in each equation is a constant of the instrument.

Hence we obtain—

$$x = G\left(\frac{\phi}{\phi'} - 1\right) \qquad (2)$$

G in our case being = 1,000.

These concluding measurements were executed in presence of the chief engineer of the I.C.G.A., Mr. T. W. W. Melhuish, and the gentlemen of the Electrotechnical Institute. This was done on November 2nd, between 11 and 12 p.m., as it was not possible to extinguish all the lamps by day.

I first measured the resistance of the net of conductors embracing the entire house, except the stage, which I shall designate as the house conductive system, in contradistinction to the stage conductive system. The house system proceeds from three copper rails, to which there leads the triple main conductive system, A, proceeding from the accumulator batteries I and II. The connection between these main conductors and the copper rails had to be interrupted. Then the measuring lead shown on fig. 3, proceeding from the torsion galvanometer, was applied to one of the three copper rails, and, indeed, to the alternative—that is, the one designed for the intermediate main conductor.

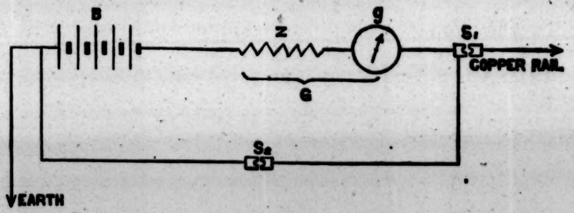

Fig. 3.

After these preparations the measurements already described were carried out according to Uppenborn's method, the plug S_1 being alternately open and S_2 closed, and inversely.

The results were as follows:—

First experiment, $\phi = 109{\cdot}3$; $\phi' = 49{\cdot}0$, therefore $x = 1{,}230$ ohms.

Second experiment, $\phi = 108{\cdot}3$; $\phi' = 48{\cdot}1$, therefore $x = 1{,}250$ ohms.

Hence the mean insulation resistance of the house system has the mean value = 1,240 ohms. The total length of the system is 100 kilometres.

The measurement of the stage net was effected in a quite analogous manner. It proceeds from the cables to which are joined the two main conductors, B, proceeding from battery III. After disconnecting these main conductors, the measuring lead was attached to one of the two stage cables, proceeding as above. The results were :—

First experiment, $\phi = 108{\cdot}3$; $\phi' = 30{\cdot}9$, whence $x = 2{,}500$ ohms.

Second experiment, $\phi = 109{\cdot}2$; $\phi' = 31{\cdot}9$, whence $x = 2{,}420$ ohms.

Thus we obtain for the insulation resistance of the stage system of conductors the mean = 2,460 ohms. The system was 10 kilometres in length.

I then connected both systems together, and found :—

First experiment, $\phi = 109{\cdot}2$; $\phi' = 59{\cdot}2$, whence $x = 840$ ohms.

Second experiment, $\phi = 108{\cdot}0$; $\phi' = 59{\cdot}0$, whence $x = 830$ ohms.

The mean value of the insulation resistance of the entire system, 110 kilometres in length, is therefore 835 ohms.

If we suppose the insulation resistance of the house system arranged parallel with that of the stage, we obtain as the resulting resistance :—

$$\frac{1{,}240 \times 2{,}460}{1{,}240 + 2{,}460} = 823,$$

which agrees well with the resistance of the entire conducting system as determined.

We will compare these results with a formula which has been proposed as a rule for judging of the character of the insulation in electrical installations, and which is, I believe, due to F. Ross, *i.e.*,

$$\text{W} = 10{,}000\,\frac{\text{E}}{\text{J}}, \qquad (3)$$

when W signifies the insulation resistance of the entire conduction, E the working tension, and J the total current introduced into the system.

It has been already said that of the total number of 5,300 lamps, 1,970 serve to light up the stage, and require chiefly 1 ampère. We obtain, therefore, for the stage conduction (system B) in round numbers, J = 2,000, and as the working tension may be taken as E = 100, according to the Ross formula we should require a resistance of $10{,}000\,\frac{100}{2{,}000} = 500$ ohms. The measurement shows a value almost five times greater, 2,460 ohms.

To the house system of conductors belong 3,300 lamps. If we take these on an average at 0·5 A, and add 100 A for the 10 arc lamps at 10 A, which belong to the house system, we have J = 1,750 A. The working tension is here double that of the stage system. We have, therefore, E = 200, and for the insulatory system which the Ross formula demands, $10{,}000\,\frac{200}{1{,}750} = 1{,}143$ ohms. Our measurements showed the value 1,240 ohms, which is decidedly greater.

In comparison with the actual consumption of current, the figures assumed in the above calculation are all too high, since all the lamps are never burning at once. According to the Ross formula, the number of the lamps fitted up, and not the number of those actually burning, must, in my opinion, decide the value of J.

For the total conductive network we should obtain, according to the calculated values of A and B (1,000 and 500) $\frac{1{,}000 \times 500}{1{,}000 + 500} = 333$ ohms, whilst the measurement gave 835 ohms.

The result of the measurement would appear much more favourable if judged, not according to the formula of Ross, but that of the Electrotechnical Association, using as coefficient 5,000 instead of 10,000. The results, therefore, satisfy the most rigid demands.—*Centralblatt für Elektrotechnik.*

THE NEW WESTON VOLTMETER.

IT is a law of human progress, nowhere better exemplified than in the industrial and mechanic arts, says the *Electrical World*, that all systematic and permanent advance depends upon our ability to determine quantitatively, in terms of some standard, the value of the various factors involved in any given operation or transformation. An idea of the crudeness of men's notions of measurement in former times as compared with the present, may be gained from the names of units or standards which have been handed down to us. Thus three barley corns made one inch ; the foot was the length of the king's pedal extremity ; the hand is a measure still in use in estimating the height of horses, &c. Compare such notions with the accuracy required in modern machine-shop practice. It is, in fact, only when the value of work already done becomes known that one is prepared to make further progress, as every step in advance demands increased refinement in the means and methods of measurement. As an instance in point, witness the mutual development of the steam engine and the steam engine indicator. Just as the indicator has advanced to a state of perfection, such that its records are universally relied upon, not only to detect faults in present apparatus and intelligently outline the direction of improvement, so has there been a gradual advance in the construction of commercial electrical measuring instruments, serving a similar purpose, and tending to effect a similar result, in electrical engineering. While it is true that thousands of engines are never indicated, and thousands of electrical appliances are never carefully tested, it is equally true, as a consequence, that useful energy is wasted, property destroyed and money lost.

In electrical as well as in mechanical engineering, success necessitates the elimination of guess work and the substitution of knowledge. Engines, dynamos, batteries, electric motors and lamps, are sold with a guaranteed efficiency and life, subject, however, to definite conditions as to use. It is generally because of the absence of definite knowledge as to when the imposed conditions are actually observed that losses so frequently exceed profits. When measurements of the value of electrical appliances are actually made, the results are often discredited because of doubt as to the accuracy of the instruments used, and probably the general indifference to accurate work manifested by many electricians may be justly ascribed to the absence of reliable measuring instruments.

Most of the commercial electrical measuring instruments in use in this country to-day are of foreign manufacture. They may be briefly described as either of the permanent or electro-magnet type. The former are in general disfavour, and unjustly so, because their defects are not inherent in the types, but are, rather, the natural result of poor design and construction. Those who have had much experience with these instruments, of which the Deprez and Ayrton and Perry are examples, will recognise the fact that while these instruments are new, they were subject to rapid and serious changes in their constant. The rate of change, however, diminished with age and use, up to a certain period, when they assume a condition of stability, and are, thenceforth, in so far as the controlling force is concerned, reasonably reliable. Uncertainty as to when this condition of stability is attained necessitates frequent calibration, and is thus a serious obstacle to accurate work. A second defect is the heating error introduced when the instruments are kept in circuit even for the short time necessary to make readings.

Instruments of the electro-magnet type are, on the other hand, more generally in demand, because of the prevalent idea that they are not subject to errors arising from a variable controlling force. Errors, however, fully as serious as have been ascribed to permanent magnets, are not only common, but seemingly inherent in this type, because of the magnetic persistency of the softest iron, even when subdivided. This error is most noticeable when readings are made with a rising, succeeded by a falling current, and often amounts to as much as 25 or 30 per cent. The best forms of this type of instrument are, perhaps, the ingenious spring voltmeters and ammeters of Ayrton and Perry. These are, however, subject to serious heating and frictional errors.

Thus far we have mentioned only the most glaring defects common to commercial instruments. Another, and almost universal defect is due to inaccuracies in the reading scale. A great advance was certainly made when direct reading instruments were substituted for those requiring a multiplying constant. It is a notable fact, however, that most of the direct reading instruments, judged by the uniformity of their scale divisions, follow the proportional law. This is extremely doubtful, however, and calibration generally reveals the fact that seldom are there more than two or three of the scale marks correct. Printed or engraved scales may justly excite suspicion as to their accuracy.

The advent of an improved type of commercial electrical measuring instruments for direct current circuits, in which the sources of error enumerated above are practically eliminated, and which are equally well adapted for both laboratory standards and commercial service, is justly to be regarded as an important step in the development of electrical instruments. The Weston Electrical Instrument Company, of Newark, New Jersey, have recently placed upon the market a new form of commercial voltmeter and ammeter, designed by Mr. Edward Weston, the well-known electrician. The especial aim in designing these instruments has been not only to entirely eliminate such variable factors as have been enumerated above, but to add to the instrument certain valuable features mentioned below. To this end, the electrical, magnetic, and mechanical details have been so worked out as to insure permanence and reliability, coupled with simplicity, extreme accuracy, a wide range of scale reading and portability. The accompanying engravings, figs. 1, 2, 3, give general and detailed views of the voltmeter. It will be seen that the field of force is produced by a permanent magnet of peculiar form, while the deflecting body, carrying the index, is a light coil of insulated wire, whose motion, resulting from the dual fields established by the magnet and current circulating in the coil, is restrained by two coiled springs. The springs serve also to convey the current into and out of the moving coil.

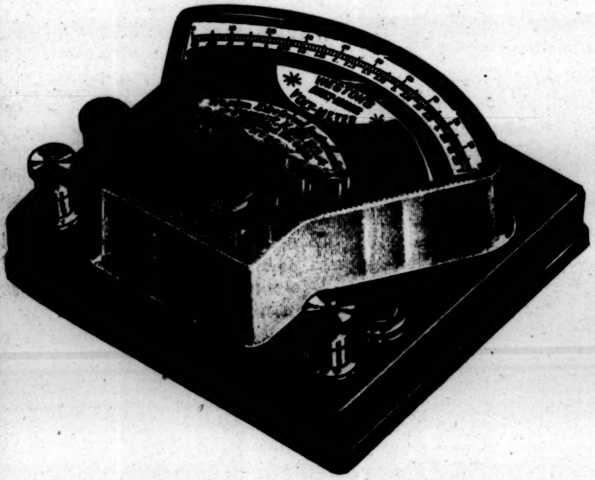

FIG. 1

That permanent magnets can be, and in fact are, daily made which, after undergoing a process of artificial ageing, remain thenceforth practically constant in strength when subject to ordinary use, is now generally acknowledged. In these instruments special care has been taken, not only in the selection of steel and its proper magnetisation and artificial ageing, but the magnetic resistance of the acting field has been reduced to its lowest practical limit by the insertion of a central core of soft iron within the movable coil. This core is supported upon the magnet frame by a strap of diamagnetic material. The form of the pole-pieces is such that the deflecting coil constantly moves in a uniform field, and hence the deflections practically follow the proportional law, and a direct reading scale, of nearly equal subdivisions, is obtained. The movable coil is wound upon a light frame of copper, which serves the double purpose of a support, and also, since it moves in an intense field of force, as a damper, thus making the instrument exceedingly dead-beat. All of the important parts of the instrument are made to gauge, and the bearings of the deflecting coil are jewelled; interchangeability of parts and the elimination of friction is thus obtained. A difference of potential of about one and one-quarter volts, at the terminals of the movable coil, serves to deflect the index over the entire scale, the length of the scale being about 6 inches. This degree of sensitiveness permits, therefore, the construction of instruments having a wide range of maximum scale-reading by the simple insertion of differentially-wound resistance coils in series with the movable coil.

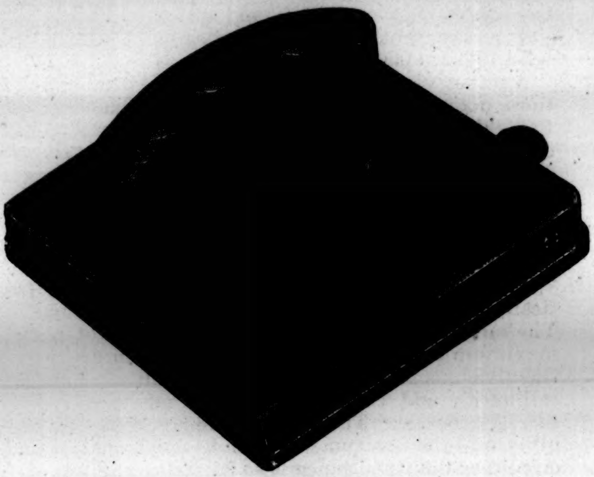

FIG. 2.

Figs. 1 and 2 exhibit the external and internal parts respectively of the new voltmeter, having a scale of double values, with a ratio of 20. The scale divisions for the upper values, fig. 1, read single volts, while for the lower values they read one-twentieth of a volt. The single divisions are of such a size that one can easily read to one-tenth of a division, namely, to one-tenth of a volt on the upper values, and one two-hundredth of a volt on the lower. This form and ratio of scale values is useful for battery work, and especially

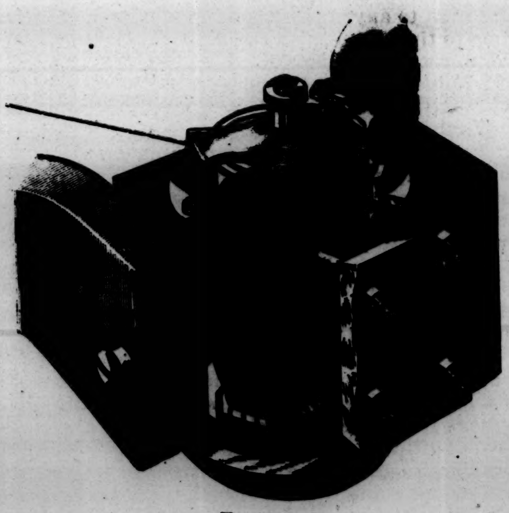

FIG. 3.

for storage batteries. The lower scale values are used when examining single cells, or sets of two; and the upper scale values when measuring the aggregate potential difference of a series of cells. In the former case, connection is made with the small binding post (under the rubber cap) on the left, and with the larger binding post on the right. In the latter case, connection is made with the two large binding posts.

Another very important feature is the means afforded those not in possession of laboratory appliances of verifying the scale value by applying a single cell of some constant form, such as is to be found in any telegraph office, to the terminals of the coil giving the lower scale reading. The deflection noted serves as a standard for future comparison with the same or a similar cell, should doubt arise as to the effect of accidental rough usage.

All scale readings begin at zero, and extend by practically uniform increments to the maximum reading. The range of scale readings for instruments of a given maximum scale is thus greater than is common, and as the divisions of each scale are the result of individual calibration and checking, the scale readings are uniformly accurate. The temperature correction is negligible, and the instruments can be kept constantly in circuit, as their resistance is so high (averaging 20,000 ohms) as to prevent any appreciable heating error. The ammeters have the same general appearance as the voltmeters, and possess the same merits of permanency and reliability.

In the hands of electricians and electrical engineers, these instruments are claimed to afford the means of obtaining measurements correct to within one-fifth of one per cent., and special instruments are made correct to within one-tenth of one per cent. If the limits of error were even ten times as great as claimed, these instruments would, it is said, possess greater accuracy than has been heretofore attainable in commercial voltmeters and ammeters. It is most certainly to be hoped that actual practice will substantiate the accuracy of these claims.

TELEGRAPH TARIFFS.

By M. LINCKENS.

Translated from the Berne "Journal Télégraphique," for Jan. 1889.

WITH the hope of throwing some degree of light upon the subject, we recur to the question of telegraph tariffs whenever an opportunity presents itself of calling attention to any erroneous impressions which may from time to time arise with regard to this matter, and with the purpose of bringing into relief, with the assistance of reliable statistics, the substantial grounds upon which we base the theories we have always maintained.

We the more readily discuss this problem, since it so frequently happens that opinions on the matter are founded upon the authority of others without the faintest attempt at personal investigation, while actual misconception of facts and circumstances are anything but rare.

Under such conditions it is very much to be regretted that too often entirely erroneous opinions, chiefly with regard to the effects of modifications of tariffs, are enunciated by the very persons engaged in this particular work. It is consequently not to be wondered at that very serious mistakes, with respect to the working of telegraph systems, should be propagated among those persons who have not such facilities for observation or opportunities of minute and detailed inquiry as possessed by the *employés* of the Administration. And that section of the public which, although not belonging to the telegraph service, still makes it matter of business to interest itself with the organisation and working of that body, is all the more easily led into error, since it places the most complete confidence in the authors of dogmas, the truth of which they are not always in a position to criticise.

In view of the figures recently given as to the telegraph traffic in Holland (See *Journal Télégraphique*, No. 11, of November 25th, 1888), we would beg permission to again revert to an argument to which great importance has been given, and which we have already attempted in these pages to refute; that is to say, the theory that the losses occasioned by a raising of tariffs are only momentary.

Since the number of internal telegrams in 1886 far exceeded the traffic in the preceding year, the partisans of the above mentioned theory make use of this argument in view of the diminution in the number of telegrams observed in 1887, and prophesy that the traffic will not long delay in resuming its progressive increase.

It is easy to rebut this speculative assertion. In fact, we need only quote the following formula:—The evil effect which the raising of rates exercises upon the development in the number of messages, will not be got rid of even when fresh sources of supply are taken advantage of.

When the public, in consequence of the cost of telegrams, abstains from using the telegraph, or when the regular clients limit their correspondence owing to the same cause, the service, as a public one, is not compensated, for the loss sustained, by the fact that the total number of messages including those from the newly opened stations may be increased or even kept to the same level.

In our opinion, before comparing the traffic previous to the raising of rates, with that subsequent to this action, it is necessary first of all to deduct the messages pertaining to the new offices, from the total number of telegrams.

If we adopt this rule when comparing the number of telegrams sent during 1886 (when the raising of tariffs took place), and 1887, we find that in 1887 the traffic was divided among the 300 Government offices (some with branch offices) at work during these years, as follows:—One office, with an equal amount of traffic in both years; 104 offices, having a total of 461,724 telegrams, that is to say, 23,405 telegrams in excess of 1886; 195 offices, having a total of 1,345,256 telegrams, that is to say, 66,634 telegrams less than in 1886.

It is easy to understand that unforeseen circumstances may arise which, independently of the price of telegrams, may affect the traffic so as to reduce the number of telegrams pertaining to any particular office, but it seems hardly justifiable to take such influences into consideration in a case where the diminution of traffic has taken place in 65 offices out of 100, at the very moment when statistics showed that in the majority of offices a very important increase in international traffic had occurred.

The number of internal telegrams sent by the 300 offices amounted to:—

In 1886	1,850,209
In 1887	1,806,980
Decrease in 1887	43,229

These figures are conclusive, although they do not really indicate the actual loss sustained. Some further corrections to the traffic must be made, and we will briefly point them out.

1. The new offices opened in 1886, numbering twenty-two, with a traffic of 5,152 telegrams, and those opened in 1887, in number 50, with 17,244 telegrams, should with their traffic be eliminated from the calculation.

2. It has been estimated that of the 11,882 pneumatic messages sent in 1886, about one-twentieth, under the old rules, were probably sent as ordinary telegrams. This same proportion should be maintained in correcting the 6,847 pneumatic messages sent in 1887.

3. As the raising of tariffs can never be supposed to increase business, we may justly consider that the 23,405 excess telegrams, representing an increase in 104 offices for the year 1887 over the preceding year, notwithstanding the raising of rates, would still have been sent, even supposing the tariff had remained the same as formerly; consequently the diminution of traffic in the remaining

195 offices should be taken in its entirety, that is to the extent of 66,634 telegrams, as representing the total loss.*

If after these statements we are still unable to convince our opponents, we yet claim to have proved that during the 18 months of the new *régime* the loss in the number of messages is much greater than is indicated by the figures which represent the total traffic, and we trust that we have shown that even an increase of traffic does not necessarily prove that the telegraphic business is prospering.

WEATHER WARNINGS.

THE Meteorological Office has issued its report for the year ending March 31st, 1888, showing how the funds placed at its disposal for the various purposes for which the office was established has been applied, together with the work done.

Popularly, the duties of the office are regarded as existing chiefly, if not wholly, in forecasting the weather which may be expected at various parts of our islands throughout an approaching 24 hours. Really this is but a very minor portion of the arduous and thoughtful work of the department. The work of the office is classed under three heads—ocean meteorology, weather telegraphy, and land meteorology of the British Isles. It is probable that no more important work is being performed than that comprised within the first named item. Undoubtedly it is of a very varied character, embracing large tracts of ocean and sea navigation. During the year no less than 182 special meteorological logs were rendered by vessels trading to and from various parts of the world. It is stated that the North Atlantic weather charts are now complete and available for further discussion, and for the detection of the laws which regulate the more important changes of weather over our islands, as well as over the North Atlantic and other portions of the Northern Hemisphere. Charts have also been made showing the barometrical pressure over the Atlantic, Pacific and Indian Oceans. Current charts for the same tracts of water are also in hand, together with many others representing the winds, currents, and surface temperature of the sea at other points.

It is to be hoped, and no doubt much good will come out of a consideration of all these conditions; unquestionably large bodies of water exercise their influence upon the atmosphere, but it is open to question whether those influences are such as to produce changes in the atmosphere beyond that of the degree of warmth or cold embodied in and to a certain extent evolved by them. The direction of the currents will again exercise a certain influence; but these influences are variable only to a certain extent, and are, as a rule, periodical in their existence. Without in any way laying claim to a meteorological knowledge of the subject, we cannot but think that to detect the laws which regulate the more important changes of the weather, we shall have to look elsewhere. What is engendered by the movements of great masses of water may be ascertained. That they have some influence it is but natural to suppose; but inasmuch as those movements are to a great extent periodical, whatever that influence it should also be periodical. If this is so, then we can hardly look to such causes and effects as a source from which to gather information for our guidance with regard to approaching storms.

The question we would ask is:—Are the conditions thus ably mapped out for consideration to be regarded as effects or causes? We take it they are mainly effects —the result of a force or power exercising influence to some extent over the condition of the atmosphere, but still not the primary cause of storms, or other violent changes of the weather.

The subject is one which may possibly appear somewhat beyond the province of this journal and we readily admit that it is with considerable diffidence we have approached it, and we venture to hope that what we have to say will be accepted in the spirit in which it is submitted, viz., with a desire to aid by any suggestion within our power a means of foreshadowing those violent atmospheric changes to which we have been—especially of late—so frequently subjected.

To determine cause and effect in this matter is doubtless difficult, and the probability is that everything which our observations may embrace will fall within the realms of effect. The primary cause is beyond our reach, and all we can do is to carefully observe the effects as they precede or follow one another, and build our conclusions thereon. This is really what is being attempted by the Meteorological Office; and, by no means, are we disposed to quarrel with what they are doing. Certain data will probably be gathered from these labours; but that which we would commend for consideration, and which we feel would afford the most ready and timely information of impending atmospheric changes, are the conditions of terrestrial magnetism. Certain it is that these changes are the result of certain influences exercised upon the stratum of atmosphere enveloping a given area of the crust of the earth. Do these influences come from without or within the planet on which we have our being? Meteorological phraseology has long accustomed us to "depressions," "anticyclones," &c. What is it produces a "depression"? We know now that when these depressions occur there will be, according to the steepness of the gradient, more or less wind—a storm, or a gale, or a hurricane. We would like to hear of some systematic observation of the electrical condition of the earth and atmosphere in the neighbourhood of these movements. So far we have for our guide and counsellor the mercury column, a guide which has served us well many a year, but evidently one which is in itself again the result of the effect of the condition of the atmosphere, and which, consequently, can only precede by a short period the change which it indicates. We cannot but think that there is to be found in the channel indicated by our remarks an effect—still only an effect—but one which will precede the mercury; and we quite believe that were our scientists to take the subject into consideration and to establish a systematic method of observation it would not be long before more timely, reliable and perfect deductions than are now drawn would be obtained.

The subject is one of incalculable value. Who shall tell the worth of the barometer, the aneroid and other weather-indicating instruments to the shipping, agricultural and many other important industries? How much more valuable would be a means of anticipating, probably by many hours at the least, even these records? To establish a systematic method of observation such as we advocate would require the services of those who possess a certain amount of knowledge of electrical science, but we do not think there would be any lack of observers if the principle or method of observation were laid down. It is probable that much information may be obtained from a careful and uniform observation of the natural currents which occupy the telegraph wires, although it is to be feared that they can ill be spared for such a purpose, at least for the greater part of the 24 hours. Still the cost of the provision of wires for the purpose would not prove a very heavy outlay. Such provision need not be very extensive—it need only embrace a portion of the country in the first instance, or until its value is tested. Observers would readily be found in officers attached to the telegraph services of the Post Office, or of our large railway companies, who would, in such a cause, be glad to render service.

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* On looking at the figures for 1885—87 (285 offices) we find:—One office with an equal number of telegrams in both years; 109 offices having an excess in 1887 of 38,868 telegrams over 1885; 175 offices having 68,121 telegrams less in 1887 than in 1885; whilst 98 of the last-mentioned offices despatched in 1887, 30,654 international telegrams more than in 1885. The number of internal telegrams pertaining to newly-opened offices amounted to:—In 1885, 15 offices, with 4,255 telegrams; in 1887, 65 offices, with 28,409 telegrams.

We feel that in tendering these suggestions we are treading upon somewhat uncertain ground, but we believe they contain that within them which will prove of utility, and we shall hope to see them taken up in some quarter. The question is one which might fairly be discussed between the Meteorological Office and the Institution of Electrical Engineers, and by no one better than the able and distinguished president of that institution, Sir William Thomson.

ELECTRICAL PATENTS IN THE UNITED STATES FOR 1888.

THE number of patents issued during 1888 upon electrical and allied subjects amounted to 1,503, distributed as follows :—

1.	Electric signalling ... ... Comprising annunciators, alarms and bells (70) ; burglar alarms ; clocks, &c. ; fire and heat alarms ; district and police telegraphs (46) ; railroad signals and train telegraphs.	185
2.	Telegraph proper ... ... Comprising autographic and automatic telegraphs ; Morse telegraph instruments, &c. (24) ; multiple telegraphs ; printing telegraphs (18) ; novel systems.	64
3.	Heavy current applications ... ... Comprising arc lamps ; electrical distribution (54) ; incandescent lamps ; lamp fixtures ; lighting apparatus ; railways and motors (137) ; transmission of power (54).	365
4.	Development, control and measurement of electricity ... ... Comprising primary batteries (84) ; secondary batteries ; dynamos and magneto-electric machines (102) ; galvanometer, &c. ; regulators and governors.	347
5.	Conductors, insulation, &c. ... ... Comprising cables ; insulated wires (17) ; pole line insulators ; insulating materials ; line wires ; supports, &c. ; underground conduits (26).	76
6.	Miscellaneous and general applications ... Comprising miscellaneous (187) ; couplings, connectors, &c. ; circuit breakers, closers, &c. (26) ; electro magnets ; electro metallurgy ; gas lighting.	264
7.	Telephony	202

THE TELEPHONE IN TUNBRIDGE WELLS.

ON Friday, the 15th inst., a meeting was held at the auction mart, Calverley Road, Tunbridge Wells, to consider the position of Mr. Powell, engineer and gunsmith of that town, who has been called upon by the United Telephone Company to pay £280 damages for fixing twenty-eight Equitable telephones in Tunbridge Wells. Mr. Daubigny Hatch, who occupied the chair, read the correspondence between the offender and the U.T.C. Mr. Powell stated, in answer to questions, that the Equitable Company professed to indemnify anyone against action by the monopolising company ; and he in perfect good faith, and without the least idea that he was doing wrong, acted as Mr. Swinton's agent. Directly the United Telephone Company demanded the confiscation of the instruments, he went round to his customers, and at great trouble and expense collected twenty-eight sets and sent them to the offices of the U.T.C. The day following the delivery of the telephones he was served with a writ for £280. Great sympathy was expressed for Mr. Powell, and it was decided that a petition should be prepared by the Chairman, praying the South of England Telephone Company to intercede with the parent company on Mr. Powell's behalf. The petition will first be signed by the subscribers to the South of England Telephone Company's exchange, and later on a meeting of the Tradesmen's Association will be called to consider the question.

TRIALS OF MOTORS FOR ELECTRIC LIGHTING.

THE Society of Arts, in December, 1886, announced the intention of offering two gold medals to be competed for by manufacturers of prime movers suitable for domestic installations of electric lighting and for other purposes. The competition was open to every class of motor, whether propelled by steam, gas, or other physical force, an entrance fee proportional to the horse power of the engine being charged, in order to cover, in some measure, the expenses attendant on the trials. A date in February, 1887, was fixed, up to which entries could be sent in, but these being insufficient it was decided to postpone the date for final acceptance, and to modify the conditions under which the medals were offered ; the rewards were increased to four gold and two silver medals, and notices to this effect were sent to many makers of engines both in Great Britain and abroad.

Notwithstanding the small number of entries received under the new terms, the Council of the Society of Arts determined to proceed with the trials, which were carried out last September. Dr. Hopkinson, Professor Kennedy, and Mr. Beauchamp Tower were appointed judges, and the whole of the experiments were conducted under their auspices. The results of the several tests may, therefore, be confidently accepted as reliable data, with the certainty that every detail on which they are founded has been carried out with the utmost care and the greatest possible accuracy.

Three gas engines were presented for trial, and one steam engine. The gas engines were a Crossley 9 H.P., a Griffin 8 H.P., and an Atkinson 6 H.P. nominal. The steam engine was a Davey-Paxman 8 H.P. nominal.

A most complete report has now been made by the judges, and published in the last issue of the *Journal of the Society of Arts*. As regards gas engines, the experiments may be considered the most valuable set of comparative tests that have ever been issued, or have been made with so much completeness, and with such elaborate measurements of all the principal quantities concerned, combined with thorough impartiality, In consequence it is to be the more regretted that the entries were not more numerous ; the absence from the competition of such well-known engines as the Stockport and the Beck is disappointing, and surely cannot have taken place from any want of confidence on the part of their proprietors as to the ability of these engines to hold their own in a public trial.

In the conditions of entry the points of merit considered of the greatest importance were :—Regularity of speed under varying loads ; regularity of speed during the various parts of one revolution, or one cycle of revolutions ; power of automatically varying speed to suit arc lights ; noiselessness ; first cost ; cost of running ; and cost of maintenance.

In estimating the comparative value to be allotted to each of these points of merit the judges were to give due consideration to the characteristics of each kind of motor, steam, gas, water, &c.

The report draws no conclusions on these points, but confines itself essentially to facts, but the Award which was published last week practically embodies the judges opinion as to their value.

The tests comprised an efficiency test during a six hours' run for each engine at full power, a three hours' run at half power, and a half-hour test running light. In the case of the gas engine trials, the quantity of gas consumed in the engine itself and in the ignition was separately measured, the readings of the meters being taken every quarter of an hour.

All apparatus employed for testing purposes was carefully checked for accuracy, the brake horse-power, in all cases was ascertained by means of a rope brake upon the fly-wheel of the engine. Two ropes were used for each wheel; they were kept apart by wooden distance-pieces. The dead load was applied by means of weights, and the back tension necessary to put the load on the brake by means of a spring balance. Readings were taken every five minutes, and its tension was deducted from the dead load. This brake gave perfect satisfaction.

The efficiency tests of the steam engine differed slightly from those of the gas engines owing to the greater power developed, and to the smaller size of the fly-wheel of the engine, it would not have been practicable in a continuous run to trust entirely to the cooling of the fly-wheel by the air. The fly-wheel, therefore, was provided with two internal return flanges, which formed a groove the full width of the face of the wheel into which water could be run, which water was continually being evaporated by the heat arising from the friction of the brake.

Indicator diagrams were obtained, the brake power and the number of turns ascertained for both gas and steam engine, but instead of measuring the gas and the cooling water, as in the gas engine tests, measurements were made of the amount of coal burnt and of water evaporated in running the steam engine

Besides the efficiency tests which are epitomised in Table I., others were made to ascertain the regularity of running and of governing. For this purpose the engines were employed to drive a dynamo machine, and the current from the machine was taken through metallic resistances controlled by switches; an incandescent lamp was also attached to the machine. This lamp would show any cyclic variation in the driving, and if this lamp burnt steadily at different loads the test would be all that was needful in a motor for working electric lighting machinery. No. 24, Table I., shows the speeds at full load, and no load, and the percentage of variation for each machine. The following is the result of this test for each engine.

Atkinson.—A slight variation in brilliancy of lamp (hardly perceptible) at full load. No hunting when load thrown off. An especial feature of this gas engine is its comparatively quiet exhaust, due, no doubt, to the low pressure reached at the end of the expansion.

Crossley.—The dynamo was driven from a countershaft with a heavy fly-wheel on it which should secure the steady running of the dynamo. No variation in light with steady load. No hunting.

Griffin.—No variation in light with steady load. No sign of hunting.

Paxman.—No variation with steady load; when load was thrown off the governor hunted considerably, causing several oscillations in the light before the engine settled down to a steady speed.

The Crossley gas-engine under trial was of the ordinary Crossley type, with the exception of the arrangement for ignition, and a countershaft with a fly-wheel running in bearings on the bed of the engine itself. To this countershaft was directly attached the dynamo, securing steadiness in running, but at considerable loss of power by the slip of the belt. The ignition is made in a closed tube kept hot by a Bunsen flame, the communication between cylinder and tube being opened at the right moment by means of a double cam on the shaft that actuates the valve, one cam being used at starting and the other when the engine is going at its proper speed.

The Griffin engine is a double-acting engine, at full power igniting a charge every third stroke at each end of the cylinder; the ignition by a slide valve and a flame. The governing is effected by omitting the gas charge when speed is too great.

The Atkinson engine differs from the former two in the connection between the piston and the crank, so that during one revolution of the shaft the following evolutions take place by the piston. Starting from the extreme back end of the cylinder it advances, drawing in gas and air, it then retires compressing the mixture, but only to a point some distance from the end of the cylinder, the charge is then ignited and the working stroke performed; and lastly, the piston retires to the

TABLE I.

		FULL POWER.				HALF POWER.				EMPTY.			
		Atkinson gas engine.	Crossley gas engine.	Griffin gas engine.	Paxman steam engine.	Atkinson gas engine.	Crossley gas engine.	Griffin gas engine.	Paxman steam engine.	Atkinson gas engine.	Crossley gas engine.	Griffin gas engine.	Paxman steam engine.
1	Date	Sep. 21	Sep. 19	Sep. 27	Oct. 1	Sep. 21	Sep. 20	Sep. 27	Oct. 1	Sep. 22	Sep. 20	...	Oct. 1
2	Trial	A	A	A	A_1	B	B	B	B	C	C	C	C
3	Duration	6 hrs.	6 hrs.	6 hrs.	6·43 hrs.	3 hrs.	3 hrs.	3 hrs.	3·12 hrs.	½ hr.	½ hr.	½ hr.	½ hr.
4	Revolutions per minute	131·1	160·1	198·1	140·48	129·6	158·8	201·8	138·10	131·9	161·0	200·1	144·20
5	Explosions	121·6	78·4	129·0	...	69·1	41·1	82·6	...	23·8	10·2	30·6	...
6	Mean initial pressure	166·0	196·9	132·3	176·6	166·5	196·2	135·1	113·0	145·5	148·0	128·0	...
7	„ effective pressure	46·07	67·9	54·15	...	47·60	73·4	55·85	...	48·59	66·7	56·60	...
8	Indicated H.P.	11·15	17·12	15·47	22·12	6·59	9·73	10·23	12·32	2·3	2·19	3·84	2·28
9	Brake load net	130·5	177·4	130·7	288·8	66·0	89·9	64·67	147·6	...	...	...	...
10	„ H.P....	9·48	14·74	12·51	19·44	4·74	7·41	6·30	9·76	...	...	...	...
11	Mechanical efficiency	0·850	0·861	0·809	0·879	0·719	0·762	0·616	0·792	...	...	...	...
12	Gas per hour main in feet	209·8	351·8	350·2	...	127·1	202·6	228·7	...	47·2	49 0	95·2	...
13	„ „ „ ignition	4·5	3·5	7·1	...	5·9	3·2	5·8	...	...	...	4·3	...
14	„ „ „ total...	214·3	355·3	357·3	...	133·0	205·8	234·5	...	...	...	99·5	...
15	Gas per indicated H.P. per hour main...	18·82	20·55	22·64	...	19·29	20·8	22·35	...	20·50	22·38	24·79	...
16	„ „ „ total ...	19·22	20·76	23·10	...	20·18	21·2	22 92	...	...	...	25·91	...
17	Gas per brake H.P. per hour main ...	22·14	23·87	28·0	...	26·80	27·34	36·30	...	...	...	...	...
18	„ „ „ total ...	22·61	24·10	28·56	...	28·10	27·77	37·20	...	...	...	...	...
19	Water per hour	680 lbs.	713 lbs.	1,022 lbs	...	260 lbs.	480 lbs.	616·6 lbs	...	...	...	...	...
20	Rise of temperature (Fahr.) ...	52·2°	128·0°	71·8°	...	67·8°	102·3°	71·31°	...	...	...	...	...
21	H.P. in driving engine	1·67	2·38	2·96	2·68	1·85	2·31	3·93	2·56	2·3	2·19	3·84	2·28
22	Mean pressure during working stroke, equivalent to work done in pumping stroke, about	1·0	2·19	2·40	...	...	...	...	...	...	...	...	...
23	Corresponding indicated H.P.	0·26	0·55	0·69	...	...	...	...	...	...	...	...	...
24	Revolutions per minute driving dynamo	128·5	162·3	199·6	140·2	Percen 1·75 %	tage of va full load a 6·57 %	riation of nd no load. 2·2 %	speed at 4·15 %	130·75	152·3	204·0	148·5

end of the cylinder, ejecting the whole of the products of combustion. The ignition is effected by a close tube, as in the Crossley engine, the regulation being obtained by altering the position of the tube. The variation of the piston stroke is brought about by connecting the piston-rod to the crank, through a toggle link and rocking lever, and jointing the connecting rod, not precisely to the toggle joint, but to a point upon the link a small distance from the joint.

The Paxman steam engine is a compound horizontal with locomotive type of boiler. The coal consumed during the long trial at full power was 2·04 lbs. per brake horse-power, and 1·79 lbs. per I.H.P. The combined efficiency of the furnace, boiler, and engine, as represented by the consumption of coal per hour, works out to 9·6 per cent.

Table II. is a comparative statement of the heat efficiencies of the several engines.

TABLE II.

	Atkinson gas engine.	Crossley gas engine.	Griffin gas engine.	Paxman steam engine.
Heat turned into work, percentage	22·8	21·2	19·2	*12·0
Heat rejected in jacket water, percentage ...	27·0	43·2	35·2	
Heat lost in exhaust, &c., percentage	50·2	35·6	45·6	
	100·0	100·0	100·0	
Actual efficiency of engine compared with a perfect heat engine working between the respective ranges of temperature ...	Per cent. 28·2	Per cent. 26·1	Per cent. 24·6	Per cent. 59

* Percentage of heat taken up by the water, which was 79·65 per cent of the total calorific value of the coal consumed.

The above tables will be sufficient for a general comparison of the different types of engines, but those who are interested in further details, such as gas and coal analysis and the analysis of their combustion products, we must refer to the report itself, which is most full and elaborate in every respect.

THICKNESS OF INSULATIONS.*

By ALEXANDER THOMPSON.

IN discussing the question of insulation in general we have heretofore confined ourselves almost exclusively to insulation resistance, but have not considered the other factors that, although not having quite the same prominence, are of almost equal importance. This evening I call your attention to the question of thickness of insulations, as required for different classes of electrical work. This paper, I regret, is incomplete, and contains only a number of suggestions that I hope may lead to good results. It was my intention to present data regarding different kinds of insulation, but my time has been so fully occupied that I have been unable to prepare them, or make a number of experiments that I had in view.

The insulation on an electrical conductor has another function to perform than simply to prevent a leakage of current. This second function is to protect the conductor from damage of any kind, and to resist as far as possible all destructive influences. It can be very easily shown that with any good insulating compound the first function is always taken care of. This is shown in the formula $\frac{(\text{E. M. F.})^3 \times \text{capacity}}{a} = \text{striking distance}$ (in inches) in which E.M.F. is in volts, capacity is in farads, and a is a quantity determined for each kind of insulation.

The following approximate values of a have been determined for the conditions and dielectric specified:

Dielectric.	Spark between.	a.
Air.	Wire and point.	263
Paraffine and cotton.	Wire and point.	5,822

Take a 4 B and S gauge wire insulated with $\frac{1}{10}$ of an inch of cotton and paraffine. This has an inductive capacity of ·704 micro-farads per mile.

With 1,400 volts as the difference of potential, and a length (say) of one-twentieth of mile as the portion of cable between the arc lamps, we find, according to the formula, the disruptive discharge to be

$$\frac{(1{,}400)^3 \times {\cdot}035 \times 10^{-6}}{5{,}822} = {\cdot}0165 \text{ inch.}$$

About one-sixth of the thickness of the dielectric.

Thus we see that so far as electrical disruptive discharges through a dielectric concern the insulation of an electrical conductor, there is little need of considering it, especially in low-tension systems, as shown by the following example: (same wire and insulation) and taking length of wire between lamps as $\frac{1}{20}$th of a mile. We have

$$\frac{(220)^3 \times {\cdot}0141 \times 10^{-6}}{5{,}822} = {\cdot}0000275 \text{inch.}$$

That is, that on a circuit which carries a current of not more than 220 volts potential, the insulation necessary to withstand any disruptive effort must only be thicker than ·0000275 of an inch. But when we come to consider high-tension currents (direct), the disruptive effort becomes much stronger, increasing as the formula shows, as the cube of the E.M.F. Take the example of an arc light plant of 50 lights, 2,500 volts, E.M.F.; distance between lamps $\frac{1}{20}$th of a mile:

$$\frac{(2{,}500)^3 \times {\cdot}035 \times 10^{-6}}{5{,}822} = {\cdot}094 \text{ inch;}$$

that is, the insulation is just a little thicker than the length of the disruptive spark.

Take an example of power transmission for a long distance, 10,000 volts.

Take length of wire between dynamo and ground as $\frac{1}{20}$th of a mile. We have

$$\frac{(10{,}000)^3 \times {\cdot}035 \times 10^{-6}}{5{,}822} = 6 \text{ inch.}$$

A most surprising result, but if Mr. Acheson's formula is correct, no ordinary thickness of insulation would withstand a ground that is perfect from the surface of one wire to the outside of the insulation of the other wire.

This last illustration is an extreme case, but it is likely to be reached any day with the rapid advance in electrical work. From these examples we see that the striking distance through the dielectric is so much greater with high-tension currents that it must be considered, and on 2,500 volts the insulation must at least be thicker than ·094 of an inch to prevent disruptive discharges alone.

Let us now consider the alternating currents.

It can be shown mathematically that a pressure suddenly applied has twice the force that it has when gradually applied, and that the sudden reversal of a pressure causes a strain three times as great as when slowly applied; that is to say, the disruptive effort of an alternating current is at least twenty-seven (three cubed) times that of a direct current of the same potential. The alternating current produces results in the dielectric that are curious indeed. The continuous charge and discharge of the conductor sets up in the dielectric a peculiar molecular disturbance that weakens it to a certain degree. I can explain its effect in no better way than comparing it with trans-Atlantic cables. There a similar condition of affairs exists—frequent reversals of the current—and it is a well known fact that in order to secure satisfactory working the cables need rest, in order that the molecules may assume a state of equilibrium. It is probable that the electrostatic capacity is in some way increased by these reversals.

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* Read before the Chicago Electric Club, February 4th, 1889.

Now, compare the number of reversals in one of these cables with the number in conductors connected to a Westinghouse machine, and judge for yourself of the effect on the dielectric in the latter case.

Let us say that the efficiency in the dielectric is decreased but one-half. Even then the disruptive effort of an alternating current is not less than fifty times greater than that of a direct current of an equal E.M.F.

Tabulating these results we have

220 volts, direct, thickness of insulation to withstand disruptive effort not less than ·0000275 inch.
1,400 volts, direct, thickness of insulation to withstand disruptive effort not less than ·0165 inch.
2,500 volts, direct, thickness of insulation to withstand disruptive effort not less than ·094 inch.
10,000 volts, direct, thickness of insulation to withstand disruptive effort not less than 6 inch.
1,000 volts, alternating, thickness of insulation to withstand disruptive effort not less than ·162 inch.
2,000 volts, alternating, thickness of insulation to withstand disruptive effort not less than 1·296 inch.

In calculating the thickness to resist disruptive efforts of alternating currents, I have not considered the decrease in efficiency of the dielectric. In each and every case the calculation is made on the assumption that the ground is perfect from one wire up to the outside of the insulation of the other, and that there is no fall of potential in the length of wire considered.

The second function of the insulator to protect the conductor and itself from injury is almost of the same importance as the first, and is one that largely determines the thickness of the insulation. In connection with the thickness of the insulation comes the question of quality of insulation, not so much as a dielectric but as a protection to resist different destructive influences. These, of course, depend upon the position in which the conductor is placed.

Taking low tension currents, we find that in general the conductors are located as follows: For overhead conductors, for underground conductors, for general current distribution in buildings, and this last is subdivided into cleated work, moulded work and concealed. For high tension direct currents we find the same general locations of conductors, and in alternating currents all except the last, but in this case comes in the possibility of a short circuit in the transformers such as would send the high tension current through the distributing conductors in the building.

The destructive influences acting on overhead conductors are chemical action of atmosphere, alternate heating and cooling through a wide range of temperature, rain and sleet, abrasion from limbs of trees, swinging of conductors against buildings, and from broken wires rubbing across them.

All these influences affect the insulation, and if its thickness is not great enough to stand a large amount of wear from these causes, it will soon become so thin that it will be less than the striking distance, and will then be disrupted and consequent short circuits ensue. The chemical action of the atmosphere generally extends no further than the surface of the insulator, and unless that is otherwise affected will with good insulating material have no bad effects. When the insulation does not stand the effects of cold and heat, by cracking, crystallising or splitting, the chemical compounds in the atmosphere having continually a new surface to attack, assist in the work of destruction, and the insulation soon becomes practically useless. The powerful effects of water, particularly when first absorbed and then frozen, soon destroy the insulation, and make it peel and crack. Abrasion can usually be prevented by care in installation, and by further protecting the insulation by a covering of braid or tape.

With underground conductors the destructive influences are mostly chemical action and water. Any one who has had anything to do with underground work has, no doubt, had the experience that thickness is most necessary for long life of cables, and that a thin insulation, no matter how good it may be both as a dielectric and a protection, will soon give way from chemical action and water.

For general current distribution in buildings the insulation suffers from destructive influences that vary with each particular case, and for many kinds of work, an insulation has not yet been made that will withstand the destructive influences present, which are generally chemical. Nor is it possible to say that destructive influences will not be present, although it is possible to imagine a case in which there is little need of insulation. Gases of different kinds may be present when least suspected, and an insulation that may have stood for years without deterioration, in a seemingly parallel case will become in a short time worse than useless.

The conclusions that may be drawn are that the efficiency or life of an insulation depends first upon its quality, and second upon its thickness. At the present time we cannot complain of quality. There are a number of good insulations that have stood very severe tests, not only as dielectrics, but as coverings for resisting water, and the effects of heat and cold, and, more or less satisfactorily, chemical action.

I have not called your attention to the handling that insulated conductors should have during the installation of the plant. Until the wireman is educated to know that insulated wires cannot be handled in the same way as a chain cable we cannot hope to get along with thin insulation. The wonder is that there are not more grounds and short circuits in installations than there are.

What should be the thickness of the insulation? Briefly stated, the insulation should have first a thickness greater than the striking distance of the spark produced by the E.M.F. of the current to be carried by the conductors; that outside of this thickness there should be such additional thickness as will enable the insulation to withstand the destructive influences that may or can act upon it, so that the life of the insulation shall be as long as the building in which it is placed.

I can explain most clearly what I mean by these two thicknesses by referring to the specifications for insulated wire required by the Navy Department:—

1. A layer of braided cotton next to the copper wire, to protect the wire and prevent kinks from the tearing of insulation.
2. A layer of white rubber containing no sulphur. This is the dielectric.
3. A layer of black rubber or okonite, for the protection of the dielectric.
4. A parcelling or wrapping of tape, to protect against abrasion.
5. A covering of lead tubing to resist chemical action.

This is ideal insulation, and for the purpose required, marine work, answers all the requirements of the case.

The fault that I would find with many insulations is that on the smaller sizes of wire they are altogether too thin, while on the larger sizes there is often more than is required.

The figures proposed heretofore conform so exactly with the best practice, both American and foreign, that I think they should be adopted. They are as follows:— $\frac{3}{32}$ volt thickness for low tension current; $\frac{5}{32}$ volt thickness for high tension current; $\frac{6}{32}$ volt thickness for alternating current.

This allows a fair margin of thickness for the second function of the insulation, except for very high tension, direct and alternating currents.

Good insulation means high efficiency, and goes a long way toward making electrical installations successful, and is cheaper in the long run, both to the contractor and the purchaser.

REVIEWS.

A First Course in Mechanical Drawing (Tracing). By G. HALLIDAY. Instructor of Mechanical Drawing and Lecturer on Mechanism at the City and Guilds of London Technical College, Finsbury. London: E. & F. N. Spon, 125, Strand.

In the introduction to his first course, Mr. Halliday points out that in the drawing office of an engineer "tracing" is the work that the pupil is first put to, whereas in drawing classes it is put down as the finishing stroke of the instruction; the proper order of things, in the latter case, is, in fact, reversed. Accordingly the author, very properly following the arrangement that is in practical work found to be the best, gives for the first course a series of 12 plates of portions of machines which the learner has to trace. Instructions are also given in the page of letterpress as to the manner in which the learner has to proceed, the colours, instruments, &c., required, the way to use the same; these instructions being eminently practical. The work, in fact, is thoroughly suited for the purpose intended.

Popular Lectures and Addresses (Nature Series). By Sir WILLIAM THOMSON, LL.D., &c. Vol. I. Constitution of Matter. London: Macmillan & Co.

The contents of this book are as follows:—Capilliary Attraction; Electrical Units of Measurement; the Sorting Demon of Maxwell; Elasticity viewed as Possibly a Mode of Motion; the Size of Atoms; Steps towards a Kinetic Theory of Matter; the Six Gateways of Knowledge; the Wave Theory of Light; on the Age of the Sun's Heat; on the Sun's Heat; Electrical Measurement. These lectures, which were delivered before various institutions, are reprinted practically in the form in which they originally appeared. Although they are well known to many readers, there are a large number to whom the republication of the same will be most welcome.

Traite Théorique et Pratique D'Electröchemie. By DONATO THOMMASI. Paris: E. Bernard et Cie., 53, Quai des Grands-Augustins.

This work is probably the most complete of its kind yet published. Commencing with a general consideration of electrolysis, in which units of measurement, electrical laws in relation to electrolysis are referred to, we have in the second chapter electrical transport, *i.e.*, the movement of liquid by the action of the current (electrical endosmose) chiefly dealt with.

In chapter 3, combinations and decompositions effected by the electric spark, the voltaic arc, &c., are considered. Chapter 4, which is, perhaps, the most important in the book, deals with the electro-chemical preparation of nearly all the elements, including the gases. We next have a chapter on "amalgams," and then a consideration of the electrolysis of mineral compounds. Again, we have the electro-decomposition of hydrocarbons and other complex compounds treated of, and finally a chapter on thermo-chemistry. The whole ground gone over, it will be seen, is very extensive, and shows that the author has been at great pains to make the subject as comprehensive as possible. A large number of valuable tables, compiled from various sources, are given throughout the work. The latter should undoubtedly prove extremely useful to those interested in electro-chemistry in its widest sense.

The Elementary Principles of Electric Lighting. By A. A. CAMPBELL SWINTON. Second edition, enlarged and revised. London: Crosby Lockwood and Son, 7, Stationers' Hall Court, Ludgate Hill.

The first edition of this work, which consisted of but 28 pages, has in the new edition been increased to 39. Of the original work we did not express a very favourable opinion, as attempts to impart information on a wide subject in a few pages must necessarily be failures more or less. The author has, however, by amplifying his descriptions, done much to improve the book, though the latter, taken by itself, will, we think, hardly give a learner a very clear insight into the subject. There is, at the same time, much which is deserving of praise in the work.

The Model Engineer's Handybook. By PAUL N. HASLUCK, A.I.M.E. London: Crosby Lockwood and Son, 7, Stationers' Hall Court, Ludgate Hill.

The contents of this book are very much of the kind met with in boys' magazines. By carefully going through the work amateurs may pick up an excellent notion of the construction of full-sized steam engines. Great attention is paid to detail, and it is evident that the author has a thorough knowledge of what he writes about. Although the construction of the well-known toyshop model engines is dealt with at first, the various chapters lead up to the actual forms of the heavier machinery. In the final chapter many particularly useful instructions and receipes are given, the proper method of handling tools, making drills, &c., being explained. Altogether, we can express a most favourable opinion of the book.

INCANDESCENT LAMP PATENTS.

EDISON & SWAN UNITED ELECTRIC LIGHT COMPANY v. HOLLAND.

JUDGMENT in this appeal, heard nearly three months ago, was delivered by Lords Justices COTTON, LINDLEY and BOWEN, on Monday, the 18th inst.

The Attorney-General (Sir R. Webster, Q.C.), Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. Bremner appeared for the plaintiffs; Sir Horace Davey, Q.C., Mr. Finlay, Q.C., and Mr. J. C. Graham for the defendants (the respondents).

LORD JUSTICE COTTON: This was an action brought against the defendants in respect of two patents, both of which have become vested in the plaintiffs, and they sought to restrain the infringement of those patents. One of them was a patent granted to Cheesbrough. In respect of that Mr. Justice Kay decided in favour of the plaintiffs and granted an injunction and consequential relief. As regards the other patent, which was one obtained by Edison, and the date of which is November 10th, 1879, he decided against the plaintiffs, and hence the appeal. Now this patent has been before this Court before, and I had the advantage or disadvantage of being one of the members of the Court on the previous occasion. There was a difference of opinion between myself and the other Lords Justices as to the true construction of the specification, but I consider myself bound by the decision of the Court on that point, and in my opinion, except on questions of fact, which, of course, must be decided by the evidence in this action, the Court ought to consider itself bound by the previous judgment. In the previous case the Court held that, if there was no anticipation of the invention claimed by Edison, it was a good subject matter for a patent, being for a combination many parts of which were not new, but which was rendered useful by a carbon bridge or burner, described as a filament, which the majority of the Court held not to be confined to the particular things described as filaments in the specification, but, I think, held that it must possess the characteristics pointed out in the specification, must be substantially the same as regards these characteristics as the particular filaments described in the specification. The Court then decided that the utility of the invention was established. Here there was a great effort made to contest the utility of the invention. This was principally based on the contention that no successful incandescent lamps were made in accordance with the specification of November 10th, 1879, and without further improvements. Inventions for the improvement of the carbon filaments followed quickly on the patent of November, 1879, which greatly assisted in the manufacture and durability of the burner of the incandescent lamp of November, 1879; that in my opinion was a useful combination, and a patent is not to be defeated simply because subsequent inventions improved the patented article, or because in consequence of subsequent improvement no article was in fact made in accordance with the specification. But in my opinion it is established by the evidence that, in fact, incandescent lamps were made by Edison in accordance with the specification of November 10th, 1879, and even sent by him to Dr. Hopkinson and publicly run by him in March, 1880. I do not see any fact now brought before us which ought to induce the Court to depart, or would justify the Court in departing, from the previous decision of the Court on the question of the invention being useful and being the good subject matter for a patent. But we then come to the objection of want of novelty, which is a question of fact. The only alleged anticipation which I need consider is that of Swan's lamp (F.J.B. 1), exhibited in December, 1878, and February and March, 1879, by Mr. Swan. In the previous case, on the evidence then before us, I thought the lamp would on the construction put by the majority of the Court on the specification be an anticipation. How does the evidence now stand? It is now admitted that the carbon burner of Swan's lamp was formed into its shape before it was carbonised, and this removes one of the points much relied on by the plaintiffs in the former action. But we have now evidence, which was not before the Court in the former action, of what was being done by Mr. Swan and by Mr. Stearn after the experimental trial of this lamp. We have the evidence of Mr. Swan and of Mr. Stearn. We have had before us the lamp, and we have the letters written by Stearn to Swan in 1879 and 1880, which were apparently admitted by counsel to show what was being done by Swan and Stearn. We see that that lamp was treated by them as a failure, and that their attempt to correct its defects led to lamps which differed more widely than did F.J.B. 1 from the lamp described in Edison's patent. This evidence assists the conclusion at which the Court arrived in the former action, that Swan's lamp of 1879 was not a success, and I think enables me to come to the conclusion that this lamp was an exhibited lamp which failed and was abandoned, and that the difference introduced by Edison was one which changed failure into success. But it was contended by the respondents that in fact Swan had used for electric lighting incandescent lamps with carbonised thread burners before November 10th, 1879. Then I come to an objection which was much relied on by the defendants, which was not raised in the former action, and which is now supported by a great deal of evidence. The objection taken as a whole was that the specification did not sufficiently show how the invention is to be carried into effect. It is necessary that this should be done so as to be intelligible, and to enable the thing to be made without further invention, not by an ordinary workman, but by a person described by Lord Ellenborough in "Haddart *v.* Grimshaw" (1 "Webster's Patent Cases," 85—87) as "a person skilled in the particular kind of work," or, as said by another learned Judge, "a person conversant in the subject." But in my opinion it is not necessary that such a person should be able to do the work without any trial or experience, which, when it is new or specially difficult, may frequently be necessary, however clear the description may be. One of the principal subjects of the attack was that part of the specification which gave directions for making a combination of lamp black and tar to form a material to make the filament to be carbonised. Before the experiments, which, by the direction of Mr. Justice Kay, were made under the supervision of Prof. Stokes, the defendants' witnesses said that useful filaments could not be made out of the material, and Prof. Crookes was particularly strong in his ridicule of the idea that tar-putty could be practically useful. Gimingham, a young man in the employ of the plaintiffs, produced and proved lamps with burners made of tar putty filaments, and after the experiments made before Prof. Stokes, the defendants contended before us, without any support from the evidence, that the material could not be effectually prepared without a trade secret, which they thought had only recently, during the course of the trial of the action, come to the knowledge of the plaintiffs, and probably had been communicated from America. It was said that this secret was the necessity of kneading the material for a length of time, and with the exercise of great pressure. In fact, Gimingham had for the trial of the previous action made lamps with tar-putty filaments, which were made exhibits in this action, and though there are no express directions in the specification how this tar-putty is to be prepared, it is stated that the material can be rolled into threads as small as $\frac{1}{1000}$ths of an inch, and I think that it would be obvious to any intelligent workman who wished to prepare the material that it must be kneaded so as to make it perfectly homogeneous, and to prevent any breaking of the thread in consequence of any particle of lampblack not being perfectly amalgamated with the tar. I think that this objection fails. But it was contended that lamps with tar-putty filaments had not sufficient endurance to make them practically useful. No point was made of this before Prof. Stokes, so that no experiments were made to test this question; in fact, on the evidence before us, many of these lamps were shown to have run for a sufficient time to prove that they could not be considered failures in this respect. Another objection taken to the specification was that no sufficient directions were given as to the carbonisation of the filament. The specification says:—"A cotton thread, properly carbonised," and speaking of the thread of tar-putty, "may be carbonised in a closed chamber by subjecting it to a high heat," but no directions are given as to how this is to be done. Before the experiments made under the direction of Prof. Stokes it was said that carbonising the filaments in a closed chamber without any packing, or with a packing of sand, as was suggested by Sir F. Bramwell, would be impossible, as the filament would be reduced to ash, but this was proved to be unfounded; and before us it was still contended that no sufficient directions as to the mode of carbonisation were given. Carbonisation was a well known term, the ordinary process having been described as roasting without the presence of oxygen. This was well known and practised before the date of the patent, and Sir Frederick Bramwell, in his evidence, said that any person who knew the ordinary process of carbonising would succeed in carbonising filaments. But it was strongly contended by the defendants and by some of the witnesses that such slender things as filaments could not be carbonised in a closed chamber without being protected by packing, which the specification did not direct to be adopted. In fact, filaments were, as sworn by the witnesses of the appellants and demonstrated by the experiments made before Prof. Stokes, successfully carbonised in closed crucibles or boxes without any packing. Moreover, though the specification says nothing about packing, any skilled workman conversant with carbonisation would take the ordinary process of packing to exclude oxygen, and would, I think, know that when so delicate an article as a filament is to be carbonised the greatest care would be necessary to prevent any possible access of oxygen. It is true that there was no trade in carbonising anything so delicate as these filaments; but great care only in exercising a known process and applying it to an unusually delicate article was wanted, and no invention would be necessary. When the defendants' witnesses failed in carbonising the filaments, I think that they did not use reasonable care to exclude oxygen, as shown in their using porous crucibles. I am of opinion that this objection also fails. Another point urged by the defendants was that the coating with a non-carbonisable substance described in the patent was injurious. The result of the evidence is that when the coating is a thin one the process can be and is done, without any injurious results. But then it was objected that the specification did not direct a thin coating, and it was objected and so held by Mr. Justice Kay that this coating was a mere pretence of coating and dusting only. But it appears that Mr. Crookes (the defendants' expert) adopted the same method of dusting. The process was, I think, in the specification proposed as preventing the filaments of the putty from sticking together during carbonisation, and what I have said about Mr. Crookes I think shows that the process which produces the so-called dusting must be considered that which would naturally be adopted. I think this objection also fails. I have dealt with the principal points urged by the defendants, though shortly, in order to avoid the extreme length which would be necessary if I were to deal minutely with the various points. In my opinion, the plaintiffs are entitled to judgment, and the appeal must be allowed.

LORD JUSTICE LINDLEY said: The validity of the patent in question in this appeal is disputed on two broad grounds, viz.:—(1) because the patentee has not particularly described and ascertained the nature of his invention; (2) because he has not particularly described and ascertained in what manner the same is to be performed. The ninth section of the Patent Act, 1852 (15 and 16 Vict., c. 83), under which the plaintiff's patent was granted, imposes upon the patentee the necessity of complying with both of these conditions in order to sustain his patent, and the patent is bad if he fails to perform either of them. The two conditions, although often confused and overlapping, are really distinct, and it is always necessary to keep each clearly before one's mind, and not to commit the mistake of supposing that compliance with one is necessarily compliance with the other. The first condition imposes upon the patentee the necessity of stating in clear and intelligible language what his invention really is, so that others may know what addition the patentee says he has made to what was known before—so that they may know what they are not at liberty to do without his consent during the existence of the patent—in other words, so that they may know what the monopoly is that is granted to the patentee. The nature of the invention must be stated both in the provisional and in the complete specification; but while it is sufficient in the provisional specification to state the nature of the invention in general terms, it is necessary in the complete specification "to particularly describe and ascertain it." The second condition imposes upon the patentee the necessity of stating, in clear and intelligible language, in what manner the patented invention is to be performed, so that others may learn from the specification how practically to avail themselves of the patented invention when the patent has expired; how they are to do what is necessary to carry out the new invention, the nature of which has been previously described. This condition applies to the complete specification only; there is no necessity to state in the provisional specification how the invention is to be performed. With reference to the degree of clearness and distinctness of the language necessary to be used in order to comply with these conditions, it is obvious that no hard and fast rule can be laid down. On the one hand, the patentee must make the nature of his invention and how to perform it clear and intelligible; on the other hand, it is not necessary for him to instruct persons wholly ignorant of the subject matter to which his invention relates in all that they must know before they can understand what he is talking about. The patentee is adding something to what was known before; and he does all that is necessary, as regards the language he uses, if he makes the nature of his invention and how to perform it clear and intelligible to persons having a reasonably competent knowledge of what was known before of the subject to which his patent relates, and having reasonably competent skill in the practical mode of doing what was then known. In complying with the first condition, and in describing the nature of his invention, the patentee does all that is necessary if he makes the nature of his invention plain to persons having a reasonably competent knowledge of the subject, although from want of skill they could not themselves practically carry out the invention. In complying with the second condition, in describing in what manner the invention is to be performed, the patentee does all that is necessary if he makes it plain to persons having reasonable skill in doing such things as have to be done in order to work the patent, what they are to do in order to perform his invention. If, as may happen, they are to do something the like of which has never been done before, he must tell them how to do it, if a reasonably competent workman would not himself see how to do it, on reading the specification or on having it read to him. The principle to be applied to the language used to comply with the two conditions is the same for both; but one class of persons may understand only one part of the specification and another class only the other, and yet the patent may be valid. In a well drawn specification the two conditions that have to be complied with are kept distinct; but in many specifications this course is not pursued. The nature of the invention and the manner of performing it are often described together. It may be that one set of words sufficiently discloses both the nature of the invention and the mode of performing it, as in "Boulton *v.* Bull." But it may be, and sometimes is, very difficult to sever the two and to see whether both are sufficiently described. Still, if they are in fact sufficiently described, the conditions must be held to be complied with, however difficult and troublesome it may be to arrive at the conclusion. I have been induced to dwell at some length on the above matters because of their importance in the present case, and of the danger of losing sight of the principles by which the Court ought to be guided in deciding it. I proceed now to enquire whether these two conditions have been performed; and I will take them in the order in which they present themselves. First, as to the nature of the invention. This court has had to consider this patent before, and, although there was a difference of opinion amongst the members of the court, the decision of the court was, as I understand it:—(1) That the expression "carbon filament," on which so much turns, was sufficiently clear and definite; (2) That the nature of the invention was sufficiently described and ascertained, and we summed up in the second claim; (3) That the second claim was in substance a claim to "every combination of any carbon filament with any receiver made entirely of glass, through which any leading wires pass, and from which the air is exhausted;" (4) That the plaintiff's "carbon filament" was essentially different from the carbon pencil used by Swan in his lamp F.J.B. 1, and that Swan had not by that lamp anticipated the plaintiff's patent. The patent was upheld notwithstanding the very wide nature of the second clause as construed. This decision is, in my opinion, binding on us so far as the construction of the specification is concerned, but no further. I do not regard the decision as binding as upon the questions whether the conditions to which I have alluded have been performed or not; for these questions depend not only on the construction of the specification, but on evidence as to the previous state of knowledge, and as to whether a person of reasonable skill could, at the date of the patent, carry out the invention wlthout further instruction than the specification gave him. I have, therefore, whilst taking the construction of the specification as settled, considered myself at liberty to exercise my own judgment on the effect of the evidence in this litigation. The construction of the specification which I consider binding involves three points, viz.: "That the specification is not too vague or unintelligible to be construed by the Court; that what is meant by "carbon filament" is reasonably plain from the specification itself; and that the second claim as construed by the Court is not so wide as to invalidate the patent. The meaning of the expression "carbon filament" appears to me to be the crucial point for determination when dealing with the question whether the nature of the invention is particularly described. This point, moreover, is, in my judgment, by far the most difficult in the whole case. Everything, I think, turns upon it. But as I was not a party to the decision, and the case will probably be appealed, I think it desirable to state that after much consideration and doubt I have come to the conclusion that what is meant by the expression "carbon filament" can be gathered from the instances given in the specification, and that what is meant is any thread which can be, and is, bent into the required form, and can be, and is, carbonised when bent. The thread, as shown by the examples, may be a fibre or a group of twisted fibres, or, as is to be gathered from the tar lampblack instances, it may be an artificial substance pressed or rolled into thread or wire-like forms. The evidence shows that at the date of the patent the expression "carbon filament" was new as applied to electric lighting. Its meaning, or in other words, the sense in which it is used by the patentee, must therefore be gathered from the specification. The sense in which the patentee has used the expression "carbon filament" can, in my opinion, be gathered from the typical examples given in the specification, and referred to in the judgment of Lord Justice Fry in the former case. The size of the filament is not stated; but it is quite clear from the objects to be attained that it must be long and thin, and nothing more definite is necessary to be stated. Having arrived at that conclusion, it follows that in my opinion the patentee has "particularly described and ascertained the nature of the invention." The next thing is to consider whether he has sufficiently described "in what manner the same is to be performed." This is a pure question of fact, and is in no way touched by the previous decision of the court. Mr. Justice Kay, however, has found this against the patentee. Having carefully attended to the evidence, and to his judgment, I have come to the conclusion that I am unable to agree with him; and I cannot help doubting whether he would have arrived at the same conclusion if he had had the advantage which we had of hearing the Attorney-General's reply to his opponents. The defendants in the first place endeavoured to make out that carbon filaments could not be made as described by the patentee. The evidence on this point was so conflicting that Mr. Justice Kay called in an expert—Professor Stokes—to assist him. This gentleman's report is absolutely conclusive in favour of the patentee upon the question whether carbon filaments can or cannot be made as described. Beaten on this point, the defendants contend that no competent workman could have made carbon filaments according to the specification without further instructions than are there given. If it be meant that few competent workmen could make them without some practice, I think the contention is well founded; but this is not sufficient to invalidate the patent. If a person is told to carbonise a thread and for want of thought or practice he takes a porous crucible for the purpose and does not protect his thread and fails, when if he had packed his crucible or had taken a non-porous crucible he would have succeeded, his failure can hardly be said to be the fault of his instruction, if a little thought and consideration would have shown that a packed crucible or a non-porous one was the right one to employ. The fact that a workman may use a wrong tool when he has a right one which a little thought may lead him to see ought to be used, does not warrant the inference that a specification is bad if it does not tell him which tool to use. Again, with respect to the tar putty, the object to be attained is plain. The putty has to be kneaded so that it can be rolled out thin without mark or flaw. Practice can alone teach any man how long and how hard he must knead; if he stops too soon and fails, is it the fault of the patentee? I should say certainly not. A similar observation applies to coating with a non-conducting, non-carbonisable substance. If the coating is made lightly by dusting all goes well; if too much is put on failure is the result. A little practice is all that is required. Mr. Crookes himself tried dusting as the most natural way of coating; and the unsuccessful coating experiments were not repeated before Prof. Stokes. I feel the great difficulty of describing in words the distinction between an amount of practice without which failure is probable, but the necessity for which does not destroy a patent, and an amount of experiment and invention without which failure is certain, and the necessity for which destroys a patent. The test, however, by which to decide such a question is, I think, to be found by asking whether anything new is to be found out by a person of reasonably competent skill in order to succeed if he follows the directions contained in the specification. If yes, the patent is bad; if no, it is good, so far as this point is concerned. Practice is one thing, experiment and trial are something different. It is settled that a patentee who does not disclose the best method known to him of carrying out his invention does not comply with the second of the conditions to which I have referred, but if a patentee says that something must be done which a reasonably competent man would know how to do the patentee need not tell him how to do it, nor warn him to be careful and to exercise such forethought and attention as the delicacy of the process to be used or the material to be employed plainly demand. The evidence upon the question whether at the date of the patent a reasonably competent man could make carbon filaments without further instruction than is given in the specification, or without further explanations, was undoubtedly conflicting, and Mr. Justice Kay, who saw the witnesses, came to the conclusion that further instruction and experiment were necessary. The Attorney-General, however, convinced me that on this point Mr. Justice Kay was mistaken. I cannot myself come to the conclusion that the patentee has kept back any secret he possessed, by virtue of which he could in 1879 make carbon filaments better than other persons possessed of reasonable skill, and who followed the directions contained in the specification with a *bona fide* desire to succeed. The evidence on this matter is no doubt conflicting, but I cannot agree in thinking that the manner in which the invention is to be performed is not stated with sufficient clearness to support the patent. There remain, however, two other matters for consideration, novelty and utility. The novelty depends on whether the Swan lamp F.J,B. 1 was an anticipation, for I am convinced that Proctor and Heaviside are wrong in the date they assign to the hairpin lamps made by Swan. The correspondence referred to by the Attorney-General is conclusive as to this matter. The lamp F.J.B. 1 was held by this Court in the action against Woodhouse and Rawson not to be an anticipation of the plaintiff's patent, but it was then supposed that the carbon pencil used in it was carbonised after, and not before it assumed its final shape. This was a mistake, and was admitted to be so in this action. The question of anticipation must be considered anew on the evidence before us. If Swan's lamp F.J.B. 1 had been a success instead of a failure, it would, in my opinion, have been an anticipation of the plaintiff's patent. The evidence, however, shows that it was a failure, and that Swan had not got the key to success; his own efforts to improve this lamp show that he was not thinking of filamentous incandescent carbons, but of other matters. Still his lamp did emit light for a time, and was very near, though in my opinion, not quite an anticipation. I agree with Mr. Justice Kay in thinking that "the point at which Mr. Edison's instrument departed from Mr. Swan's was crucial, and the departure, though slight, has all the merits of a new invention and produces a new result." The question of novelty I am considering is closely connected with, although really different from, the question of sufficiency of description given of Swan's lamp. Can it be said that Mr. Edison added anything to what was known, and sufficiently described the nature of what he added? In my opinion he did not in words distinguish his lamp from Swan's, but gave a description of a new type of body to be rendered incandescent, or, if I may use such an expression, a new type of wick. One mode of trying this is to ask if any one would make such a thing as Swan's lamp if he took Edison's specification. He would not. The two may be made to shade off into each other, but this does not prevent a man from perceiving the difference between the two types and adopting the one which succeeds. The utility of the patented invention is incontestable; and Mr. Justice Kay's opinion to the contrary is, I think, to be attributed to the view he took of the construction of the patent, a matter which, as I have said before, I consider settled by the previous decision of this Court. Before concluding, I ought to notice the very formidable objection taken by Mr. Justice Kay to the validity of the patent on the ground that the second claim is for a monopoly of incandescent lamps containing a filament of carbon for a burner, and that such a claim is far too wide considering how much Edison had invented. Whether this view here is correct turns, in my opinion, on what Edison had invented when he introduced "carbon filaments." That was, I think, a new departure of the highest importance in electric lighting, and if this be so, the claim is not too wide. For the reasons above stated, I am of opinion that this patent, construed as it has been by this Court, is valid, and that the appeal ought to be allowed.

Lord Justice Bowen said: In order not to add more than is necessary to the voluminous literature on the subject of this patent, I will express my views as briefly as possible. As regards the construction of the second claim, I think we ought to follow a principle which has been already decided by the majority of the Court in the case of the former action; but as I retain the same opinion as I then formed, this point becomes less material. The patent appears to me to claim in distinct and unmistakable language every combination of any carbonised filament with any receiver of glass through which leading wires pass, and from which the air is exhausted. Whether a claim so framed is too vague, or too wide, or ought to be the subject of a patent, or whether it is wanting in novelty or utility, constitutes an enquiry which in part, at all events, may be said to be bound up with questions of fact; and as far as all such points are concerned, I think it desirable to judge this appeal *de novo* upon its independent merits. Construing claim 2 as embracing all combinations such as I have mentioned, is it too vague? I see no reason to doubt that in the year 1879 the term "filament," though new at that date as regards electric lighting, would nevertheless convey to the minds of ordinary persons of the class to whom this specification was addressed, the idea of a slender thread or threadlike substance, and it seems to me that the specification indicates that the thread or filament was first to be formed, and then to be subsequently carbonised. On page 2 of the patent the thread is distinguished from a rod. "Heretofore light by incandescence," says Mr. Edison, "has been obtained from rods of carbon. I have discovered that even a cotton thread, properly carbonised, will produce the requisite effect." The instances given in the specification, which are enumerated in the judgment of Lord Justice Fry and myself in the previous appeal, and in the judgment of Mr. Justice Kay, are illustrations of the sense in which the term, which appears to me to be in itself intelligible, is used. The term "filament" is nowhere defined. It is a descriptive term, not a definition. But it appears to me to indicate the nature of the particular factor in the combination in a way that describes and ascertains the nature of the invention, so as to render it plainly intelligible to a skilled person of the class to whom the specification is addressed. (His Lordship here referred to the language of Lord Herschell in the case "Badische Anilin Fabrik *v.* Leverstein," 12 "A.C.," 720.) The merits of the filament as distinguished from a rod are manifest. The filament or thread has an extremely small sectional area; it is flexible before carbonisation, and resilient afterwards. It is true that these merits are not explained, but I know of no law which renders it incumbent on the patentee to explain them. It appears to me, moreover, to be proved not only that every successful lamp since 1879 which is of avail for multiple arc lighting has employed a filament, but also that there is no proof that any filament cannot be adapted to the patented combination. If this is so, why is the claim too wide? It is not the fault but the virtue of the invention that it covers so large a field. We have been pressed with the argument that the Edison patent is useless, and that no lamp in the market has been made exclusively on the patent of 1879 without the aid of subsequent improvements. Improvements of real value followed with great rapidity on the patent. Their rapid succession does not destroy the legal validity as regards usefulness of the original combination to which such improvements were felicitously applied. The utility of the invention, which was admitted in the Woodhouse case, has been challenged in the present action, but I think unsuccessfully, and the evidence shows that lamps made solely on the patent will and do succeed, although subsequent improvements have been generally engrafted on the original design. Was the Swan lamp an anticipation? We know now what the Court did not know in the last action—that the carbon conductor in that was formed before it was carbonised. Was it a filament? The question is one of degree. I doubt whether it is a filament, and I still more doubt whether any one who saw it would understand it to be such. But in any case I think that lamp never was more than an experiment, on account of its failure and barrenness of all fruit, and that it was regarded even by its inventor as practically valueless in the race. The correspondence in evidence shows, I think, to demonstration that till the middle of the year 1880 Mr. Swan did not consider himself to be upon the right track. Certain dates put forward seem to be inaccurate, and I think there is reason for believing that it was Mr. Edison's patent which led back the world of electricians to the true path. Certainly from the date of its exhibition that lamp disappeared from history till it was exhumed for the purposes of the trial in the Woodhouse case. With respect to the remaining points raised in argument before us I have nothing to add to what has been said by my brothers. I think this patent constituted a new departure in electricity, that the specification sufficiently describes and ascertains the nature of the invention, and that no reasonably competent person alive to the delicacy and care obviously requisite in forming and carbonising so slight a thing as a filament ought, without any exercise of invention, but with reasonable watchfulness only and fair good will, to have been embarrassed in making and carbonising Mr. Edison's filaments. The appeal, in my judgment, should be allowed, with the usual results as to the costs; and I think I ought in conclusion to express my own personal obligation for the conspicuous clearness and ability with which this case has been placed before us at the Bar.

The **Attorney-General** asked for certificates that the validity of the patent came in question, and that they had proved their breaches. He also asked for a delivery over of the stock of infringing lamps on affidavit, and an enquiry as to damages.

Sir **Horace Davey**: That is by the defendants.

The **Attorney-General**: I have to speak about the third parties directly. That raises a difficulty, and I do not know how my learned friend is going to deal with it. Now, my lords, the Brush Company are third parties, and fought the action. The action was originally brought against Mr. Holland, who was the contractor for the Albert Palace; the Anglo-American Brush Company appeared, and said they would indemnify the defendants. The action was tried as between the plaintiffs and the defendants and the Anglo-American Brush Company. I should desire to argue whether we are not entitled to have an injunction in this action as against the third parties. I do not know that my learned friend will dispute it; it is a case in which the third party would clearly be held to be estopped. I am not sure whether we are not entitled to further relief, but I do not know what view Sir Horace Davey would take about it without consideration.

Lord Justice Cotton: There is nothing in this judgment on the Cheesbrough patent as regards the third parties.

The **Attorney-General**: I have had nothing to do with that particular matter, and I do not know how that was arranged. All I do know is that in the proceedings in the Court below the Brush Company appeared as third parties, and throughout conducted the matter. With reference to our rights against third parties, I am perfectly willing to make either a substantive application to your lordships, or to consider it more carefully.

Lord Justice Cotton: What I am afraid of is that you are introducing a new practice, not justified by the order of the Act of Parliament. These third parties are not defendants. If those who are with you had amended and made them defendants it would have been different.

After a prolonged discussion upon the point,

Lord Justice Cotton said: A point has been raised here which is a curious one, but it arose after judgment. I thought the matter very simple, to give the judgment now to apply to both patents which Mr. Justice Kay has given as regards the one which he decided in favour of the plaintiffs. But the plaintiffs now claim to treat the third parties as if they were the defendants, not only in the way of making them pay costs, but also in the way of granting relief against them—granting an injunction and consequential relief. As regards that, I think it would be wrong, because the third parties are not defendants. If a plaintiff has a direct claim against a third party, the proper course is to amend the statement of claim and make him a defendant, and then the Court has all that jurisdiction as against the defendant which it gains by serving that party with a writ and bringing him in as a party to the action. Why that was not done here I cannot understand, except that possibly the plaintiffs did not like to bring in any other person against whom they were liable for costs if they failed. We do not wish that there should be unnecessary litigation. I do not see that for that reason we can assume a power which in my opinion we have not got. It is very true that when this third party came in and desired to defend the action, and the direction was given, he might have had that liberty on his undertaking to submit to any judgment which the Court might think fit to give as against him, supporting the interest of the defendant, and really by the person who ought to have been made defendant. But that was not done. The order which was made was simply an order in these terms, that he should "be at liberty to appear at the trial of the action and take such part therein as the Judge shall direct, and the said Anglo-American Brush Electric Light Corporation, Limited, shall be bound by the decision of the Court in this action as to any question of the above indemnity which may arise between that company and the defendants." If the plaintiffs were not satisfied with that, they ought to have said, "No, that will not do for us; other terms ought to be imposed upon this third party." But the proper course, looking now still to the origin of the jurisdiction, and that which brings a person within the jurisdiction of the Court, would have been for the plaintiff to amend his appeal and say, "Here are the real persons who are disputing or infringing this patent." That course was not taken for some reason; I do not know why. In my opinion we have no jurisdiction to make a decree against this third party as if he were a defendant, and to grant an injunction against him and grant damages against him in this action as if he were made a party. Whether he will be unwise enough to dispute the plaintiff's rights as regards this patent when another action is brought against him I cannot suppose. But then the Attorney-General says, "Give me leave to amend;" and Mr. Aston says that we ought to make such order as the Court ought to have made below, and to make such amendments as may be necessary for that purpose. But what was the course taken by the plaintiffs on the trial in the Court below? In the Court below they never asked for this relief as against this third party. It is very true there was an expression by Sir Horace Davey which was relied upon, that the third party sought to be put in direct relation with the plaintiff. I do not quite understand myself what that meant.

It is not as clear as Sir Horace Davey's expressions usually are. But these parties did not act upon that, and treat it as a statement that the third party should be made a defendant. It may have been immaterial then, because the costs given to the defendant were the costs of the defendant as regards that part of the action in which the plaintiff failed, and costs were given as against the defendant as regards that part of the action on which the plaintiffs succeeded. In my opinion it would be wrong under these circumstances, and in the course which has been adopted by the plaintiffs now, to grant liberty to amend to enable the Court to give different relief against the third party than that which was asked for at the trial of the action. Now as to the costs. As regards the costs of the appeal, as the third parties do appear on the appeal, and as they were served with notice of appeal, there will be no difficulty in making an order against them for the payment of the costs of the appeal, and in my opinion the Court has jurisdiction, having regard to Rule 54, to make them pay the costs. Therefore, as regards this part of the action, I think it would be wrong to alter the judgment. As regards the other part of the action, we may, when we alter the judgment of Mr. Justice Kay, make an order against the third party as well as against the defendants, and payment of the costs of the action.

LORD JUSTICE LINDLEY: In substance the third parties here are the people who fought the plaintiffs, and if I had tried the case and come to the same conclusion I have done on the merits, and had been asked to amend by making the third parties the defendants, I should have done it without the slightest hesitation, and I am not at all sure that if I were sitting alone on the appeal I should not do it now. I think there is power to do it, but I will not differ from my learned brother upon that point. There is a little doubt as to whether it ought to be done and so let in the very wide terms of Order 28, Rule 1. When you see, at least apparently, that no conceivable injustice can be done—there are no merits in it, it is a mere matter of form—I should get over it. However, as I say, there has been no amendment. As to costs there is no difficulty at all. Rule 54 of Order 16 clearly gives power to make what order we think right as to costs. Now, what order is right? Those who really fought the plaintiffs and failed should pay the costs. The order will be that the third party do pay the costs here and below.

Upon further application, costs upon the higher scale as regards the proceedings in the court below were granted, and also a certificate of proof of breaches.

NOTES.

Proposed Electric Lighting at Southampton.—At the last meeting of the Southampton Town Council, a letter was read from Messrs. Sharp, Harrison, Turner and Turner, stating that they were instructed by the local Electric Light and Power Company to apply to the Corporation for permission to open the pavements in the main streets of the town, for the purpose of laying underground mains to be used for the supply of electric light and power to the shops, public buildings, and private houses in the streets named. The company had no intention to undertake street lighting. Upon obtaining the consent asked for, and an agreement having been entered into with the Corporation, the company would apply to the Board of Trade for the necessary license. The company would carry out its work under the supervision of, and to the satisfaction of the Borough Surveyor and bear all costs and expenses connected therewith, besides undertaking in the event of their discontinuing their operations to restore the streets to their former condition. With the exception of the contractors, Messrs. Crompton and Co., who were large shareholders, the company entirely consisted of Southampton gentlemen, and they, therefore, hoped for a more favourable consideration of their application than might be accorded if it came from those having no connection with or interest in the town. It was decided to refer the matter to the General Works Committee.

Electric Lighting in Bulgaria.—Her Majesty's Agent and Consul-General at Sofia reports that the municipality of that capital has decided to light the streets of the town, and the ministries, consisting of ten houses, with about 20 rooms in each, with electric light. Tenders for that purpose will be received by the Municipality of Sofia, up to the 13th April, and it is desirable that communications should be made in French or German, if possible.

Wakefield and the Electric Light.—At last week's meeting of the Wakefield City Council Alderman Peacock suggested that the city, or a portion of it, should be lighted with the electric light. He said the Corporation was paying the Gas Company £1,908 14s. 6d. per year for gas for the public lamps and buildings, and according to an estimate which had been supplied to him they could light the town with electricity at a cost of about £995 per year. After a discussion on the matter it was agreed that it should be considered in Committee.

London and the Electric Light.—The St. George's Vestry has resolved to assent to the granting of a license for seven years, by the Board of Trade, to the House-to-House Electric Lighting Company, authorising that company to supply electricity within the parish. The same company wrote to the St. James's Vestry last week asking for a reconsideration of its resolve not to consent to the company's application for a license, but the vestry remained firm, and decided to adhere to its former resolution. The Holborn Board of Works has sanctioned the applications of the London, Metropolitan, and House-to-House Companies, the two first for provisional orders and the last for a licence.

The Electric Light at Barnet.—According to the *Barnet Press* there have been several minor failures in connection with the electric light—the light going out for short periods—during the past week. The expert employed to test the light has sent in his report, which was discussed in committee at the Board on Tuesday evening. The light, says our local contemporary, has been at its best lately, so that the report was probably made under favourable conditions as regards the contractor.

Bath and the Electric Light.—The fear of danger from overhead electric light wires has induced a town councillor at Bath to give notice of his intention to move a resolution that, when the electric light is introduced into Bath, as it will be almost immediately, it shall be by means of underground conductors. Of course, up to the present, overhead wires have been contemplated for economical reasons, but Mr. Massingham has intimated his readiness to employ underground conductors if the council is prepared to go to the extra expense.

Station Lighting.—Mr. Wollaston Pym has written to the newspapers to complain of the way in which the stations on the underground from Cannon Street to Aldgate East are lighted. "In each of them," he says, "a poor, miserable little hairpin of an electric light makes it impossible to see the name of the station on the great round lamps which, by real honest gaslight, used to announce the fact." This is only another illustration of the necessity for confining the employment of incandescent lamps to indoor illumination. Gas is a far better agent for lighting even railway stations than 5 or 10 C.P. incandescent lamps.

Liverpool and the Electric Light Question.—At Tuesday's meeting of the Liverpool Watch Committee, a recommendation was submitted from the engineer, suggesting the appointment of an electrician to supervise the details in connection with the electric lighting question. The matter was discussed at some length, and eventually it was adjourned until further enquiries may be made. An opinion was expressed that the duties of the new post might be performed by an official chosen from the corporation staff, but it was explained that any person who undertook the responsibility should be thoroughly versed in the principles of electricity. At a previous meeting a resolution was passed that the city engineer communicate with Mr. Shoolbred and report further as to the appointment of an electric inspector under the provisions of the Liverpool electric lighting licence.

The Electric Lighting Question at Halifax.—The special committee of the Halifax Town Council which has under consideration the application on the part of several electric lighting companies for concessions, has decided in favour of granting such concessions, but no particular company has been selected. The committee is of opinion that in granting a concession care should be taken by the Town Council to avoid being saddled with any pecuniary responsibility.

Electric Lighting in the Houses of Parliament.—A small steam engine and dynamo capable of working about 120 extra electric lights have been erected at the Houses of Parliament, thus increasing the total number in the building to 620. Seventeen of the additional lights have been placed in one of the reporters' writing rooms, and the remainder are supplied to the members' entrance lobby, staircase, and corridor. After Easter the light will probably be extended to the Commons' lobby, St. Stephen's Hall, the offices immediately adjoining the House, and several of the Ministers' and reporters' rooms.

Electric Light at Windsor Castle.—The Queen has, it is said, approved of the electrical installation which has been introduced at Windsor Castle, under the auspices of Sir John Cowell, the Master of the Royal Household. The incandescent lamps in the corridor were used for the first time since the return of the Court on Tuesday night, and proved a great success.

Telephone Extension in East Kent.—The Telephone is rapidly extending in this district. Communication between Canterbury and Faversham will be established in the course of a fortnight, unless anything unforeseen happens to delay the work. The line has already been erected from Canterbury to Denstrood. Subsequently the Whitstable and Herne Bay district will be opened up.

Multiplex Telephony on Long Lines.—Mr. D. S. Sinclair, engineer to the National Telephone Company, has read a paper on this subject to the members of the Glasgow Philosophical Society. The lecturer described his paper as a resumé of what had been done, and what was likely to be done in regard to this subject. He showed that in no way could multiplex be done on single wires as such, but by employing return loop circuit wires three sets of telephones could be used on two such circuits. In America four sets of instruments on two circuits had been tried, but this the lecturer condemned, holding that that system destroyed the qualities of loop circuits, while using three sets retained them. He said it was difficult for outsiders to understand how more than a couple of speakers could use a wire at one time without the slightest interference from overhearing. That this was quite possible, however, the lecturer showed by drawings and description. He declared improvements in matters telephonic were not yet at an end. Mr. Sinclair was accorded a vote of thanks for his paper.

The Telephone on the German Frontiers.—The German authorities have just completed the necessary preparations for the installation shortly of a telephone line between Berlin and Posen. The latter place is to be placed in telephonic communication with all the principal garrisons on the Russian Frontier.

Submarine Telegraphy.—M. Cornu has just praised, at the French Academy of Sciences, M. Wunschendorff's work on submarine telegraphy. This work, very complete from an electrical point of view, is also of great interest to naturalists, for it treats on the insects which destroy the gutta-percha insulation of the cables.

Light Electro-Motors. — Some remarkably light electro-motors have been designed and made by Mr. Trouvé for aeronautical experiments. They are of the Gramme and Siemens type, and one weighing only 90 grammes (3·18 oz.) is capable of developing ·026 horse-power on the brake. The machine is of aluminium, except the magnets. This motor, attached by a wire to a fixed support, lifts itself 22 metres ([illegible]2 feet) in one second, and a 1-horse motor constructed on the same scale would weigh about 3·5 kilos (less than 8 lbs.).

A Blizzard Meets an Electric Road.—Recently one of the severest tests to which an electric railroad can be subjected was experienced by the Davenport Electric Line, installed by the Sprague Electric Railway and Motor Company of New York, at Davenport, Io., and one which proves most conclusively that an electric railway can be operated even under the most adverse conditions of weather. According to *Science*, the blizzard, which had been howling about the Dakota prairies during the first part of the week, and getting up its strength by snowing in the territory farmers, decided to come south, and on January 9th struck the city of Davenport. The snow, which was of the heavy damp variety, fell all day, and covered the streets to the depth of from four or five inches to one foot on a level, and in several places caused deep drifts over the line of the electric railway. In spite of this, the cars on the electric line kept running uninterruptedly, carrying a large number of passengers, and proving conclusively that no amount of snow could prevent the cars from running to time.

The Channel Cables Difficulty.—The *Central News* says the attitude of France in regard to taking over the cables of the Submarine Telegraph Company has placed the British Post Office in a position of considerable difficulty. M. Coulon still insists on the laying of new cables instead of taking over the old ones, and has just given formal notice that France intends granting to the Submarine Company a further prolongation of the term for the working of the cables between the two countries until the difficulties existing between the two Governments are removed, or until new Anglo-French cables have been manufactured and laid. This practically makes it impossible for the British Post Office to take over the working of the French cables on April 1, the date previously arranged. On the other hand, the Post Office is bound by agreement to commence working the German and Dutch cables by the above-named date, and if those Governments insist upon their contracts being rigidly adhered to the Continental traffic in telegrams will be divided between the Submarine Telegraph Company and the General Post Office, a state of affairs almost certain to lead to friction in the working. Last week a conference was held at Cologne between the heads of the Telegraph Departments of Germany, Holland, Belgium, and Great Britain (Mr. Lamb representing the British postal telegraphs) to arrange for the further working of the wires between Great Britain and those countries, but whether any revision of existing arrangements was then definitely decided upon has not yet transpired. From the opinion of experts, however, it is believed to be impossible for the Government to take over the working of the German and Dutch cables by April 1, and the same opinion is even more strongly held in respect to the Belgian cables. There is only too much reason to believe that the action of France in this matter has been dictated in a spirit of retaliation for the uncompromising attitude taken up by the British Government two years ago, when the proposal of France to grant the Submarine Telegraph Company a further concession for a term of years was effectively vetoed.

Submarine Telephone Line.—According to a *Times* telegram from Brussels, the first submarine telephone line is being established between Buenos Ayres and Montevideo by the Belgian Company, Mourlon and Co. The cable will also transmit telegraphic messages.

Scientific Experiments in the States.—According to American reports, Barnum has been lending his menagerie to some "scientists," who have been experimenting with a "powerful battery of 42 Leclanché cells." Various animals were tried, baboons and seals and gnus objecting. Even elephants were shocked. Now we think Barnum was running the risk of wasting good elephants. *Fiat experimentum in corpore vili* is a good old maxim, if we have quoted it correctly. We could have lent the scientists a few. Next time they have a powerful battery of 42 Leclanche cells, we hope they will experiment on some of the electropathic people, the Court of Appeal, or on Mr. Chamberlain. Luckily, however, the elephants liked it. They rubbed their legs together with pleasure like flies, and screamed with rippling childlike laughter. The scientists finally regret that, after all, their powerful battery was not enough to dessicate the elephants. "We should have had enough strength to have killed something." Here we have the true instincts of British sport. The electrical resistance of the gnu is 11,000 ohms, the eland 7,280, the oryx 7,010, and the gnyqlghaugh (we are shaky as to the spelling of this beast) 5,090. These figures will be exceedingly valuable to the compilers of electrical pocket-books.

Good Business.—The record of Mr. Schuckert, of Nuremberg, is one which requires a lot of beating. Recent statistics show that he has turned out of his establishment 10,000 Pilsen arc lights and 3,500 dynamos, and he has installed 200,000 incandescent lamps. It would be interesting to know how these figures compare with any one of our leading firms.

An Electrical Fare Register.—A want has long been felt for an apparatus of a simple kind which should give an absolutely accurate registration of the fares in street cars. An instrument which seems to be capable of circumventing the ingenuity of the conductor who, if he is so inclined, can generally get the best of any check which may be placed upon his propensities for appropriating that which does not belong to him, is about to be put upon the market by the American Electric Register Company, of Boston. It is worked electrically, and from the description and drawings which we observe in *Practical Electricity*, we think that by its employment the dividends to shareholders in omnibus and tramway schemes might be increased, for it is well known that a certain percentage is always allowed for the defalcations of *employés*.

A Good Report.—The third annual report of the Brighton and Hove Electric Light Company seems to be of a very satisfactory nature. Mr. Arthur Wright has worked hard to secure success, and he deserves to be heartily congratulated on the results of his untiring efforts. It is interesting to note that the company's mains now extend a distance of over 20 miles, and that the old multiple series system of lamps has been replaced by the converter method of working which enables lights to be turned out singly instead of in groups as has hitherto been the case. That which will appeal most forcibly to those who like to see money in anything to which they devote attention is the declaration of a five per cent. dividend, and the further proceedings of this company and that at Taunton will now be watched with still greater interest.

Electrical Supply from Gasworks.—The last issue of *Practical Electricity* contains a paper by Mr. R. B. Taber "On the working of a combination of gas and electricity." From the experience of the author, it is very evident that a gas company can handle electric lighting plant with advantage. To the question, Does it pay? Mr. Taber does not give any direct answer; but from the fact that his people are erecting a new building to accommodate 1,200 horse-power, we imagine that his answer could only be in the affirmative. We believe such a combination might be tried with advantage in this country, and probably the day is not far distant when such combinations will become common.

Equitable (?) Telephonic Proceedings.—Mr. Powell, of Tunbridge Wells, seems to be having a hard time of it at the hands of the United Telephone Company's managing director. It would be well if this gentleman felt a little more inclined to temper justice with mercy, for the persecution of Mr. Powell looks as if he were prompted by feelings more akin to vindictiveness than anything else. Moreover, the interests of the South of England Telephone Company should not be overlooked, for it will not be surprising if some of the subscribers in Tunbridge Wells declare off if their fellow-townsman be treated too harshly.

The Graphophone.—The Graphophone Syndicate has been registered with a capital of £100,000, to acquire the seven British patents issued to Bell and Tainter, together with applications for others now pending. Our opinion of the utility of the graphophone is already known to readers of the REVIEW, and so far we see no reason to modify our views. That it cannot become commercially successful in this country is a moral certainty, whatever may be its fate in the States.

Interesting to Inventors.—Under the title of "The True Position of Patentees," Mr. H. Moy Thomas has published, through Messrs. Simpkin, Marshall and Co., a little book in which the patent laws and regulations at home, abroad, and in our colonies and dependencies are explained for the information of English inventors.

Personal.—Mr. W. Slater, representative of the Western and Brazilian Telegraph Company, Limited, in Brazil, has been made a Commander of the Order of the Rose.

Presentation.—An interesting ceremony took place on Monday evening, February 18th, at the offices of the National Telephone Company at Leeds. The staff and men of the Leeds district testified their esteem and respect for their late manager, Mr. Ralph Mewburn, by presenting him with a beautiful solid gold medal and a purse of gold. Mr. Mewburn has been in the service of the "National" nearly nine years, and during the past four years was manager of the Leeds District. The presentation was made on behalf of the staff by Mr. J. C. Chambers, general manager of the Yorkshire District. May Mr. Mewburn long be spared to cherish such a souvenir of his value to the telephonic interests.

Mexican Cables.—Our contemporary the *Electrician*, in its issue for February 8th, contains a note referring to certain cables which are now being laid in the Gulf of Mexico. The note reads as follows:—"Advices from the City of Mexico state that a second cable is to be laid between Vera Cruz and Galveston during the present spring." Considering that the *Faraday* left Messrs. Siemens's works on December 21st, 1888, with cable to be laid between Galveston and Goatzocoalcos, our contemporary's information can scarcely be called either new or accurate. We are glad to see that in its issue of February 15th the *Electrician* has corrected its previous error.

New York Subway.—Notwithstanding all that has been done in New York City, with the object of placing overhead wires in conduits, it is estimated that there are to-day more miles of overhead wires than existed a year ago. The following is a list of electrical wires, with their mileage, placed in the subway up to January 1st:—

	Miles.
Metropolitan Telegraph and Telephone Company ...	4,062·32
Western Union Telegraph Company	39·08
Brush Electric Light Company	8·87
Edison Company...	192·23
New York City Fire Telegraph	101·02
	4,403·52

Motors for Electric Lighting.—The Council of the Society of Arts, on the award of the judges, Prof. A. B. W. Kennedy, F.R.S., Dr. John Hopkinson, F.R.S., and Mr. Beauchamp Tower, have awarded a Society of Arts Gold Medal to each of the following competitors :—Class A. Motors in which the working agent is also produced. (Steam) : Davey Paxman and Co., Standard Iron Works, Colchester.—Eight horse-power compound portable engine. Class B. Motors to which the working agent must be applied. (Gas—Engines worked by illuminating or other gas) : 1st. Motors under ten horse-power (actual)—British Gas Engine and Engineering Company, Albion Works, Mansfield Road, Gospel Oak, N.W.—Six horse-power nominal Atkinson's "Cycle" gas engine. 2nd. Motors over ten horse-power (actual)—Crossley Brothers, Limited, Openshaw, Manchester.—Nine horse-power nominal "Otto" gas engine. 3rd. Dick, Kerr and Co., 101, Leadenhall Street, E.C.—Eight horse-power "Griffin" gas engine.

Smoking Concert.—The fourth smoking concert of the City and Guilds of London Institute Old Students' Association is to take place at the Manchester Hotel, Aldersgate Street, on Saturday evening.

Use for Storage Batteries.—Whatever difficulties there may be in the way of employing storage batteries in large and permanent installations, there can be no doubt as to their utility for temporary illumination. A recent example was the lighting up of a private residence on the occasion of a ball. Two series of 35 cells each of the Electrical Accumulator Company's "15 A" cells, connected in parallel, supplied current for 90 16-C.P. lamps from six in the evening until four in the morning : 60 lamps were used in the ball room, and 30 in the supper room. In both cases the lamps were distributed round the sides of the rooms. The cells were charged at the company's works, and carted to the house on the day of the ball.

A Sign of the Times.—The Anglo-American Brush Electric Light Corporation, Limited, has just secured an important contract for the supply of about 40 sets of combined engines and dynamos of its special design, and has now in hand orders for nearly 50 sets of apparatus of this pattern. The design has met with much favour from the European Governments since its introduction, and has been largely adopted for lighting ships of war and other vessels. The Brush Corporation has also booked a contract for the application of its system of electric traction to an important tramway line in Spain.

NEW COMPANIES REGISTERED.

Graphophone Syndicate, Limited.—Capital : £100,000 in £10 shares. Objects : To acquire the seven British patents taken out by Bell and Tainter, Nos. 6,027, 6,042, 6,047, 6,062, all of 1886 ; 16,384, of 1887, 1,851 and 1,851A, of 1888, relating to the reproduction of sound, together with applications for others now pending, upon terms of two agreements of 31st ult., the first between Woodhouse and Rawson, Limited, and John Hamilton Ward, and the second between Walter T. Glover & Co. and John Hamilton Ward. To carry on business as electricians, electrical contractors, electrical and mechanical engineers. Signatories (with 1 share each) : F. L. Rawson, 11, Queen Victoria Street ; J. H. Ward, 55, Shelgate Road, Wandsworth ; J. C. St. Quinten, 38, Lee Road, S.E. ; J. McFarlan, Invermay, Wimbledon ; Sir R. W. Rawson, C.B., 68, Cornwell Gardens, W. ; Sir F. Leopold McClintock, 5, Atherstone Terrace, S.W. ; J. Offor, Park Hill Villas, Sydenham. The subscribers are to appoint the first directors, one-third of whom are to be nominated by the Volta Graphophone Company, of Virginia, U.S.A. Qualification : 100 shares. The remuneration of the directors is to be appointed by the company in general meeting, but £1,000 per annum is to be the maximum. Registered 14th inst. by Sydney Morse, 4, Fenchurch Avenue. Registered office, 11, Queen Victoria Street.

Mines and General Telpher Company, Limited.—Capital : £4,000 in £1 shares. Objects : To enter into contracts for constructing and working lines for the carriage of minerals and other materials, under a licence granted by the United Electrical Engineering Company, Limited. To carry on in any part of the world the business of electricians, mechanicians, and engineers. Signatories (with 1 share each) : *Hy. Foote (electrical engineer), 11, Queen Victoria Street ; E. R. Ward, 55, Shelgate Road, S.W. ; T. A. Nunwick, 8, Charlwood Place, S.W. ; F. E. Smith, 2, Tanfield Court, Temple ; *J. Henderson, C.E., Malabar, Truro ; *L. Milne, C.E., 15, Great George Street ; J. H. Pezzack, 9, Malmsbury Road, Bow. The signatories denoted by an asterisk are also directors. Registered 15th inst. by Lee and Pembertons, 44, Lincoln's Inn Fields, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

City of Westminster Electrical Syndicate, Limited.—At a meeting of the shareholders in this syndicate, held at 6, Westminster Chambers, Victoria Street, S.W., on the 19th December, the following special resolution was passed :—"That Mr. Charles Stanley Peach be elected a director of the company, jointly with the present directors, Mr. Bonwick, Mr. Cleave, Mr. Cooper, and Mr. Barnes." The resolution was confirmed on the 15th ult., and filed on the following day.

Eagle Iron and Engineering Company, Limited (engineers and makers of electrical appliances).—The statutory return of this company, made up to the 13th November, cites that of the nominal capital of £6,000, in £5 shares, 946 shares have been taken up, and that £2 10s. per share has been called and paid thereon, the paid up capital thus being £4,365. Registered office, 17, Hertford Street, Coventry.

H. Dale and Company, Limited (electricians).—The statutory return of this company is made up to the 15th November. The nominal capital is £10,000, in £5 shares, 600 shares have been issued, and these are considered as fully paid. Registered office, 26, Ludgate Hill.

Scientific Appliance Manufacturing Company, Limited.—The statutory return of this company is made up to the 15th November. The nominal capital is £10,000, in £5 shares, 600 shares have been allotted and are considered as fully paid. Registered office, 9, Kirby Street, Hatton Garden.

LEGAL.

In re the London Electric Supply Corporation.—Queen's Bench Division.—Tuesday. (Before Baron Huddleston and Mr. Justice Manisty.) Mr. R. S. Wright moved, on behalf of Mr. W. N. Daniells, for a rule absolute for a *certiorari* to remove into the High Court any indictment which might be found at the now pending Middlesex Quarter Sessions against the London Electric Supply Corporation, Limited, for an alleged nuisance to a highway. They could not appear at Sessions, and it was therefore necessary to remove the trial. Their Lordships granted a rule.

CITY NOTES, REPORTS, MEETINGS, &c.

Submarine Telegraph Company.

THE report of the directors states that the accounts for the six months ending December 31st, 1888, show a net sum which enables the directors to add the usual proportion of the receipts to the reserve fund, to recommend a dividend for the half-year at the rate of 16 per cent. per annum, and to carry over a balance of £628 19s. 3d.

The dividend paid for the corresponding period of 1887 was at the rate of 15½ per cent. per annum.

The number of messages transmitted during the six months was 1,846,002 containing 20,328,271 words. In 1887 there were transmitted 1,695,860 messages containing 18,701,557 words. The average length of messages in 1888 was 11·01 words against 11·03 words in 1887.

The receipts of the half-year show an increase of £3,886 13s. 4½d. over those of 1887, and the expenses show an increase of £1,283 6s. 6d. This increase is principally caused by the insertion of much new cable when repairing several of the cables interrupted in the half-year, and by the thorough overhaul and repair of the steamer in the first six months of 1888, to which reference was made in the last report of the directors. The proprietors were then informed that only £500 of the cost was charged in the accounts for June, 1888, and that the balance, £407 14s. 9d., would be charged in the accounts of the present half year.

The proprietors are no doubt aware that the company's concessions and agreements with the Postmaster-General and with the foreign Governments expired on January 12th, 1889. The directors have to report that the respective Governments agreed to allow the company to continue working their own cables, as well as those belonging to Her Majesty's Government, until March 31st, 1889.

No arrangement has yet been definitely arrived at between the directors and the Government for the acquisition of the company's property; but considerable progress has been made, and as the Government has decided to take over the property on April 1st, the matter cannot be much longer delayed. The directors would have been glad to submit for the consideration of this meeting definite terms of agreement with the Government, but at the date of this report they are unable to do so.

The Brighton and Hove Electric Light Company, Limited.

THE third annual report of this company states that the capital account has, during the year, been augmented by the sum of £3,100, which has enabled the company to increase the capacity of its plant, and to extend and re-arrange the circuits. The profit and loss account, after writing off an ample sum for depreciation of plant (which has, however, been kept in thorough repair out of revenue), shows a balance of profit for the year of £532 12s. 9d., which, with the balance brought forward from last year's accounts, makes the sum to the credit of profit and loss account £603 0s. 8d., and the directors recommend the following appropriation of it:—

Dividend of 5 per cent. per annum on the share capital...	£574	11	10
Carried forward to next year's profit and loss account	28	8	10
	£603	0	8

There has been a steady increase in the company's business during the past year. The mains belonging to the company now extend a distance of *over twenty miles*; reaching westward as far as King's Garden, Hove; eastward as far as Belgrave Place, Kemp Town, and northward as far as Hanover Crescent, Lewes Road.

At the beginning of the year, in deference to a very general request, the company arranged to run the machinery day and night; and though this has added considerably to the cost of working, it has given great satisfaction to the customers.

With the view also of placing the electric light within the reach of an extended number of customers, the company has adopted a sliding scale of charge, which gives the consumer the benefit of a considerable reduction in price. This reduction came into operation on the 1st of January this year.

During the past year the company has almost entirely transformed its method of supply, and replaced the old multiple series system with the converter system, by means of which it is possible to turn off lamps singly, instead of in groups as hitherto. These changes have largely increased the number of the company's customers.

The exact nature of the improvement in the company's business may be seen by the following statements:—(*a*) Lamps supplied from the company's mains on—

December 31st, 1887, equivalent to 2,970 10-candle-power lamps.
" " 1888 " 5,500 " "

(*b*) Quantities of electricity supplied from the works during the past year, as compared with corresponding months of previous year:—

UNITS SUPPLIED.

	1887.	1888.	Percentage of increase.
January	5,260 ...	7,533 ...	43 per cent.
February	3,865 ...	5,430 ...	40 "
March	3,444 ...	4,550 ...	32 "
April	3,188 ...	4,813 ...	51 "
May	2,180 ...	3,359 ...	54 "
June	2,056 ...	2,707 ...	31 "
July	1,985 ...	2,687 ...	35 "
August	3,552 ...	4,300 ...	22 "
September	4,801 ...	5,419 ...	14 "
October	6,337 ...	7,615 ...	20 "
November	7,512 ...	12,567 ...	74 "
December	8,738 ...	13,930 ...	60 "
Totals for the twelve months	52,918 ...	74,910 ...	41 per cent.

During the past year, the Board of Trade have represented to the company the advisibility of applying for statutory powers, in order to enable it to change its method of distribution by means of overhead wires to a system of underground mains; and in view of the increasing demands for the electric light in Brighton and Hove, and the necessity of laying cables underground in order to cope with a large business, the company made application in November last for a Provisional Order under the Electric Lighting Acts, 1882 and 1888, and this Provisional Order is at present being considered by the Board of Trade.

The company has given a pledge to the Brighton Corporation and the Hove Commissioners to largely increase its works in the event of the Provisional Order being granted, and the necessary formal meetings have been held to sanction the raising of the nominal capital of the company from £25,000 to £100,000, and the change of the name of the company from the Brighton Electric Light Company, Limited, to the Brighton and Hove Electric Light Company, Limited.

When the directors deem the time opportune, the shareholders will be called together and consulted with regard to further plans for the extension of the company's operations.

Mr. Arthur Wright, who has brought the works to their present state of efficiency, has continued to act as managing director; and the thanks of the shareholders are due to him for the highly satisfactory manner in which he has conducted the business of the company during the past year. He reports that the engines and dynamos have continued to give satisfaction, and are at the present time in thoroughly good working order.

During the past year, Mr. William Smithett, one of the directors of the company, has resigned his seat on the board in consequence of his leaving Brighton, and his place has been filled up by Mr. Thomas Webber Jerrard. The board has also been strengthened by the election of Mr. Philip Arderne Latham. The retiring directors are Mr. Robert Hammond, chairman, and Mr. Arthur Wright, managing director, who offer themselves for re-election.

Telegraph Construction and Maintenance Company, Limited.

THE directors' twenty-fifth annual report states that the accounts for the year show a net profit of £82,580 3s. 6d., after charging the interest on the debentures. To this sum must be added £50,436 10s. 10d. brought forward from last year, making a total of £133,016 14s. 4d. From this amount is deducted the interim dividend of 5 per cent., paid July 17th, 1888, amounting to £22,410, leaving £110,606 14s. 4d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income tax, leaving £43,376 14s. 4d. to be carried forward to the next account.

During the past year the cable factories at Greenwich and the gutta-percha department at Wharf Road have been fairly employed. A length of about 6,000 miles of telegraph wire has been insulated, including submarine and land lines.

The company's steamships have laid cables between the Dutch possessions in the Eastern seas, and at the present time are engaged triplicating a portion of the Eastern Extension Telegraph Company's system to Australia.

Various repairs have been made in cables in the North Sea and in the Brazilian line between Madeira and St. Vincent; and the Direct United States Company's Atlantic cable has been placed in good working condition, repairs having been effected at a maximum depth of 2,200 fathoms.

The charter of the steamship *Kangaroo* to the Italian Government, for distilling purposes in the Red Sea, continued up to the end of May, and the company have since disposed of her. The steamship *Calabria* has been on charter since November last.

The company's works at East Greenwich and Wharf Road are in efficient working order.

It is with regret that the directors have to announce the death of their late colleague, Lord Alfred Paget. They have elected, to fill his place, Mr. William Shuter, who has held an important and responsible position in the company since its formation.

The £150,000 Six per Cent. Debentures have been replaced by the issue of a like amount bearing interest at 5 per cent. for a period of five years from January 1st, 1889.

London Electric Supply Company, Limited.—The directors have offered for subscription £250,000 6 per cent. preference shares of £5 each. Holders will have the option, on or before December 31st, 1893, of converting their shares, when fully paid up, into ordinary shares. The directors assume that a net profit of £60,000 per annum will result from the operations of their Deptford Station, and upon this handsome sum (which we hope they may earn) the interest on the preference shares will be a first charge.

TRAFFIC RECEIPTS

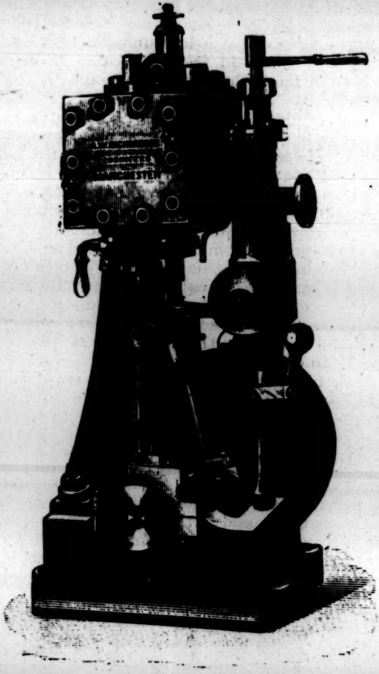
The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 15th, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,506.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th February are £3,046, as compared with £3,424 in the corresponding period of 1888.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended February 15th amounted to £5,346.

THE RICHARDSON HIGH SPEED ENGINE.

THIS engine, as illustrated, has been specially designed by Mr. W. A. Richardson, of Manchester, for dynamo driving, direct, or by belt or ropes; it is also adapted for driving centrifugal pumps, fans for forced draught, and for any purpose when great power and high speed is required in a small space. It has been constructed with great care to run at high speeds with safety and economy, and without excessive wear. The crank is made of mild steel, carefully balanced, the cylinder and upright are cast in one piece, the cylinder is steam jacketted and is fitted with a liner which, with the valve face, can be at any time renewed. The piston rings and valve are of phosphor-bronze. All bearings are extra long and are made of phosphor-bronze and best gunmetal. The crank shaft bearings are fitted in square with wrought iron caps. The glands are specially constructed for tightening whilst running, without the risk of jamming on the rods. The governor is of the high speed class and is very sensitive, and can also be adjusted whilst running. All forged parts, bolts, studs and nuts, are made of mild steel. All parts are made to template and are interchangeable. The lubricating arrangement is perfect and is adopted for long and continuous running. In mills and other manufactories (also steamships) where the electric light is used, the most practical way of driving dynamos is direct by small high speed engines where there is boiler power to spare, as the lights can be started before work commences, and can also be kept going at night until all hands are off the premises, and can also be kept running all night in case of repairs. These engines take up little room, as the engine is fixed on same bedplate as dynamo.



These engines are intended to meet the demand for a good, reliable, economical and practical high speed engine at a moderate price. Engines of this class can be fitted with automatic expansion arrangement if required.

AMERICAN NOTES.

By DAS TELEPHON.

THE attention of inventors and patent attorneys is called to the following decision rendered by the Supreme Court of the United States on 21st inst., in the case of the Bate Refrigerating Co., appellant *v.* George B. Hammond & Co., appeal from the Circuit Court of Massachusetts:—

"1. By statue of the United States, it is provided that when a patent is taken out in a foreign country, and one subsequently is also secured in this country, the patent shall expire in the United States with the expiration of the patent in the foreign country in which it first runs out. Under the Canadian law, patents are granted for five years, with the privilege of a renewal for two periods of five years each. The question in this case was whether the lifetime of the American patent expired five years from its issuance in Canada, or at the end of 15 years, which is the limit to which the life of a patent may be extended in Canada. The Supreme Court, through Justice Blatchford, holds that the patent in the United States does not expire for 15 years from the granting of the patent; that is to say, that the lifetime of an American patent first taken out in a foreign country does not expire until the extreme limit of time for which an extension of patent may be secured in the foreign country. The court, therefore, reverses the decision of the Circuit Court of Massachusetts, and remands the case to the lower court, with instructions to enter a decree in accordance with the judgment of this court."

The above decision establishes finally that a patent taken out in the United States subsequently to the issue of a patent for the same invention in a foreign country for limited term, with the privilege of renewal, does not expire at the end of the first term of the foreign patent, but only when the foreign patent *actually* expires.

Attention is called to the decision published in "American Notes" in the REVIEW of June 15th, 1888, which was that when the foreign patent *issues* before the U.S. patent, although the application for the U.S. patent was made prior to that for the foreign patent, the U.S. patent expires with the foreign patent.

Advice is, do not file application for a foreign patent until your application shall have been allowed by the U.S. Patent Office, and *after* the application shall have been filed in foreign countries, pay your private fee to the U.S. Patent Office.

According to the law which is now in force in the State of New York governing execution, "the punishment of death must in every case be inflicted by causing to pass through the body of the convict a current of electricity of sufficient intensity to cause death, and the application of such current must be continued until such convict is dead." Grave doubts are expressed, even by the friends of the new method, whether the law, as it stands, is effective, because it does not provide for specialists or scientific executioners or electrical apparatus to carry out the sentence. Under these circumstances it is claimed that the new law amounts to little more than an indefinite suspension of the death penalty for murder. A number of practical electricians and one or two scientific authorities still contend that electricity is not suited for the work assigned to it; on the other hand, the advocates of the change rise unitedly, as heretofore, to claim for it the advantages of certain, instantaneous and painless death. On two points, however, there seems to be practical unanimity of opinion, namely, that it will be necessary to experiment on a few criminals before the executing machinery can be skilfully manipulated, and that expert electricians must take the place of *Jack Ketch*.

A communication has been received at the Mayor's office from Mr. Harold P. Brown, electrical engineer, of New York, about the danger of the wires used by the electric companies to light the streets. He says the pressure adopted for putting criminals to death is exactly the pressure used for what is termed "safe and harmless" electric lighting. As a remedy he suggests a limitation of the pressure to 300 volts, or less, in order to make it more safe, and says such a pressure would entail the cost upon the companies of twice as much wire as is now used.

Death by electricity will probably prove entirely painless. Thus the condemned felon of to-day finds a far less terrible revenge awaiting him at the hands of the law than did the criminal of past generations. The story of the tortures undergone by convicted men in olden times is almost revolting to contemplate, and yet the barbaric ingenuity displayed by the official tormenter is interesting in view of the recent change in the method of inflicting the death penalty.

Another astonishing swindle of vast proportions is brought to light in the collapse of the Electric Sugar Refining Company.

If the central figure in it had not died there is no telling how long the final exposure might have been evaded. The defrauding of the investors, as in the parallel Keely motor case, might have been continued indefinitely.

"Professor" Friend seems to have discovered some method of making refined sugar whiter and of changing the appearance of its crystallisation. This enabled him to produce an article differing somewhat from any in the market. He asserted and pretended to show that he manufactured it from raw material by an electrical process known only to himself, and which was so inexpensive that it would bring untold wealth to those who could exclusively utilise it. There was a verification of the old saying that none can be convinced so easily as those who want to be. Half proofs are accepted as unmistakable demonstrations.

Men of good business standing believed that Friend possessed the secret, though he would not reveal it, and advanced him or for his purpose $350,000, and perhaps more. The glamour of inordinate profit blinds the judgment of men of accredited capacity even. It is idle to call the victims constitutional fools.

The offices of the Electric Sugar Refining Company at 69, Wall Street, were crowded yesterday at noon, for it was announced that President Cotterill was going to make a complete statement of the company's condition. He did not do so, however, but confined himself to a discussion of his private character, and left the company to take care of itself. He appeared to think that the Press had not treated him well.

In relation to the company President Cotterill said :—" After full consultation with the officers of this company, stockholders in this city, and representatives here of the English shareholders, it has been determined that it would be highly injurious to the interests of the stockholders to give the Press at this time a statement, such as had been contemplated, of the history of this company, the negotiations which have been recently passed for the disclosure of the process, their results leading to the exposure of the fraud, and the steps which have been and are being taken for the purpose of bringing to justice and accountability the persons who have so grossly defrauded the company by false representations of the process. Much as the officers of the company would, for personal reasons, desire to furnish such a statement, it cannot for the above reasons be given for the present, but will be as soon as it is considered expedient in the interests of the stockholders to do so."

Baltimore, *February* 1*st*, 1889.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"On certain phenomena connected with imperfect earth in telegraph circuits." By A. E. KENNELLY, Associate.

Since the earliest days of commercial telegraphy—the days that first reaped the labours of Sœmmering and Steinheil, Gauss and Weber, Cooke and Wheatstone—the substance of our planet has been impressed into such universal conducting duty that now scarcely a circuit closes, be it across an ocean, or be it across a meadow, but embraces its share of the earth in its completion; and the task thus imposed is generally borne so readily, and executed so perfectly, that, until the existence of the eavesdropping telephone, it was really doubted whether in truth the earth could or did conduct the current entrusted to its care.

Considering, then, the great obligations telegraphy owes to the earth—that the existence of some hundred thousand miles of metallic conductor, at present in daily telegraphic operation, implies in a certain sense the corresponding twin existence of an equal length of terrestrial conductor ready made by Nature; that it has even been possible to telegraph over a space of which the metallic conductor formed but a very proper fraction—the cases that are met with where the earth fails to fulfil its part excite astonishment more by their rarity than by the force of those laws whose mandates they obey.

Almost all such cases of imperfect earth are, we know, traceable to some fault either in the earth connection itself or in its immediate neighbourhood; and a remedy is found by adequately increasing the surface area of the buried electrode, or the conductivity of the ground in its vicinity; so that they are not really failures of the earth's conduction, but failures in securing the necessary degree of connection with the earth's mass.

There are, however, other cases, brought about by conditions more deeply seated and more rarely met with, which will occupy our present attention.

A paper by Mr. James Graves, "On vibrations due to earth plates," was read before this institution in January, 1875, and it will be seen that the phenomena therein described are probably related to those that will be presently detailed. Although the matter has not occupied the institution's direct attention since that date, no doubt some of its members will have independently observed similar phenomena, and can bring forward such additional evidence as cannot fail to elucidate a subject at once replete with technical interest and important practical bearings.

These phenomena are presented by the Atlantic cables of the Direct United States Cable Company, with whose permission the facts are laid before the institution.

The two cables of this company, terminating in Nova Scotia, run to Ireland and to Rye Beach respectively. Their landing place was originally Torbay, N.S., but they were removed thence to Halifax some 18 months since.

The Irish cable was first brought into the cable-house, situated 40 feet above high-water mark, upon the beach opposite George Island, on the 23rd October, 1887, and it was put in communication with the town office by means of a line cable and a return earth cable, side by side, in an iron pipe. Each cable was 0·7 knot long, had a resistance of 8·3 ω, a capacity of 0·25 φ, and a high insulation. The line cable united with the Irish shore end through lightning guards, while the earth cable made good soldered connection with the shore end sheathing.

Some vibration of the mirror spot, due to electrical disturbance, was noticed on first joining up the circuit at the office through instrument and condensers, but this was at the time attributed to faults which then existed in the cable. Beyond this continual vibration, no noteworthy feature occurred until six days later (29th October), when the Rye Beach cable was landed at the same cable-house, and joined up with the office by a precisely similar pair of cables running through iron piping in the same trench with the other above-mentioned. This cable is worked on the double-current Morse system without condensers, and it was immediately noticed that sending to Rye Beach with 12 volts of battery power visibly disturbed the mirror spot on the Irish circuit, although each cable made earth separately through its own sheathing *viâ* the insulated return cables to the beach. Receiving from Rye Beach did not disturb the mirror, nor did the operation of the Irish cable in its turn affect the less delicate apparatus of the Morse circuit.

The only remedy that could be, or has since been, practically available, without adding to the retardation of the circuits, was the reduction of the Morse battery power on one hand, and the sensitiveness of the Irish mirror on the other, as far as the operation of the circuits would conveniently permit.

After the removal of the faults in the Irish cable the vibrations of the mirror still continued, and it was noticed that not only these, but periods of disturbance coincident with local meteorological changes, affected the signals more than had been on record with the same circuit when worked previously from Torbay. On this was superposed the interference caused by transmission on the Rye Beach circuit, and the combined disturbance at times made the mirror signals difficult to read.

The Rye Beach shore end was at first laid very near to the Irish cable, and actually over it at one or two points. The cables were, however, subsequently separated, although they still necessarily lie at different points in close proximity. This separation of the cables was found to have sensibly lessened their interference.

The operation of the cables from the cable house instead of from the office was found to produce no change in the nature or degree of disturbance, while experiment failed to produce any visible interference between the trenched cable circuits from office to Beach, even on the most delicate instruments.

A third cable was then laid from the cable house across the harbour and out through the eastern passage in the direction shown on the diagram. It had a total length of 5·8 knots sheathed up to within half a mile of the sea end. This unsheathed half mile of core terminated in a copper earth plate one yard square, nearly on a line between Thrumcap Rock and Hartland Point, This well-insulated line offered every prospect of securing a good and independent earth by its large terminal plate. When, however, it was joined up at the cable house with the Irish circuit, in the place of the Irish shore end sheathing, the interference from the Rye Beach transmission remained as marked as ever.

To determine the nature of this obstinate interference, a series of experiments was made at the cable house as follows :—

All existing connections were for the time dismantled, and only the two cables, the two earth wires soldered to their respective sheathings, and the core of the third cable, or six mile earth, were brought to the testing table.

The resistances between these three earth wire terminals was measured as follows by bridge :—

Between Irish sheathing and Rye Beach sheathing	0·16 ω	all steady.
„ „ „ „ six-mile earth ...	65·7 ω	
„ Rye Beach „ „ „ „ ...	65·7 ω	

From which the resistance of each sheathing earth connection would, of course, be 0·8 ω, and of the six mile earth 65·6 ω.

The only apparatus then retained for investigation was a Daniell battery of 14 gravity cells—used with, and sometimes also without, a pole changer—for exciting disturbance, and a sensitive speaking mirror—used with, and also without, condensers of 40 φ capacity —to render any interference visible.

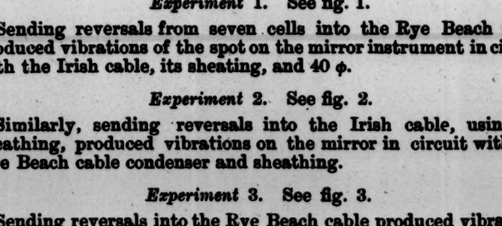


FIG. 1.

Experiment 1. See fig. 1.

Sending reversals from seven cells into the Rye Beach cable produced vibrations of the spot on the mirror instrument in circuit with the Irish cable, its sheating, and 40 φ.

Experiment 2. See fig. 2.

Similarly, sending reversals into the Irish cable, using its sheathing, produced vibrations on the mirror in circuit with the Rye Beach cable condenser and sheathing.

Experiment 3. See fig. 3.

Sending reversals into the Rye Beach cable produced vibrations on the mirror in circuit with the Irish cable condenser and six mile earth.

Experiment 4. See fig. 4.

Sending reversals into the Rye Beach cable, using the six mile earth, produced vibrations on the mirror in circuit with the Irish cable condenser and its own sheathing.

Experiment 5. See fig. 5.

Sending reversals into the Irish cable, using the six mile earth, produced vibrations on the mirror in circuit with the Rye Beach cable condenser and its own sheathing.

Experiment 6. See fig. 6.

Sending reversals into the Irish cable, using its own sheathing, produced vibrations on the mirror in circuit with the Rye Beach cable condenser and six mile earth.

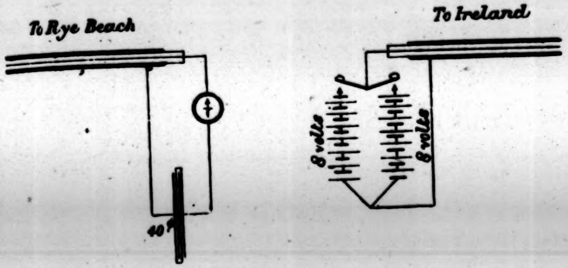


FIG. 2.

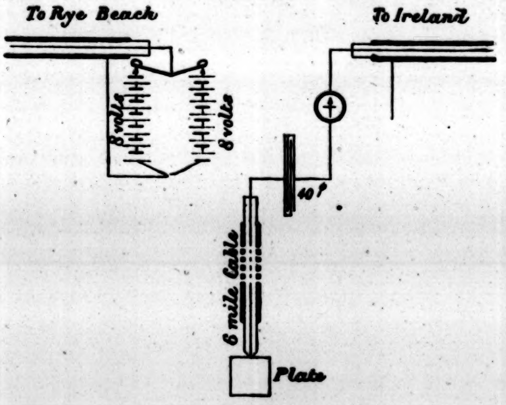


FIG. 3.

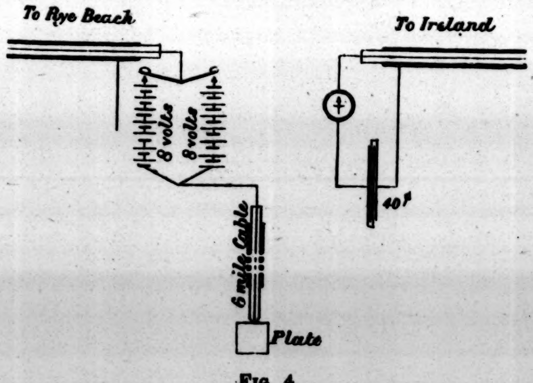


FIG. 4.

Experiment 7. See fig. 7.

Sending reversals on the circuit formed by the six mile earth, battery, and Rye Beach sheathing, the disturbance on the mirror in circuit with the Irish cable condenser and sheathing was more decided than in any of the preceding experiments.

Experiment 8. See fig. 8.

Similarly, sending reversals on the circuit formed by the six mile earth, battery, and Irish cable sheathing, the disturbance on the mirror in circuit with the Rye Beach cable condenser and sheathing was equally great.

Experiment 9.

The two last experiments were repeated with the condenser removed and the mirror in direct circuit between cable and sheathing. The continual vibration of the spot made observation difficult; but during periods of comparative quiescence it was soon determined that the disturbance produced by depressing one of the keys was not of of a momentary nature only, but consisted of a small deflection, permanent during the whole period of key application, and of direction depending upon the key selected. It was also ascertained that this deflection was not due to any local electro-magnetic action by

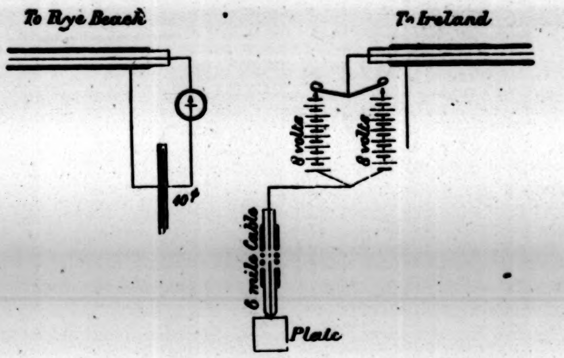


FIG. 5.

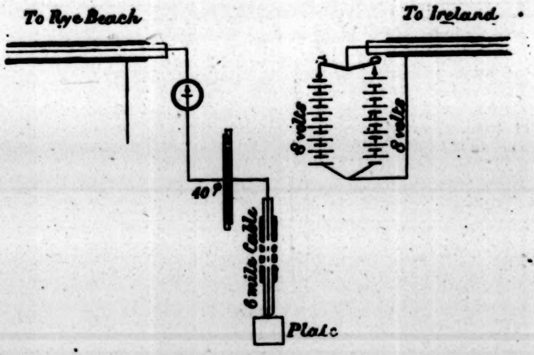


FIG. 6.

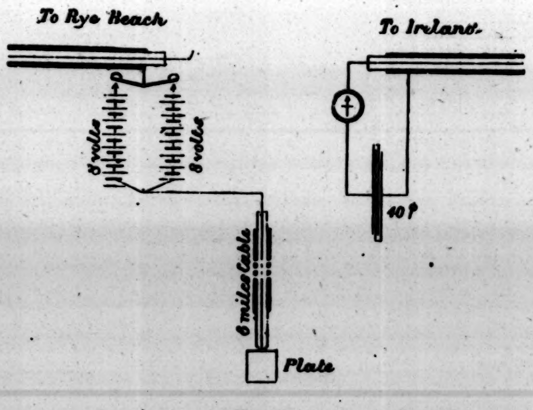


FIG. 7.

Experiment 10. See fig. 9.

On sending reversals between the two cable sheathings in circuit with the battery, no disturbance could be detected on the mirror in circuit with one of the cables and the six mile earth.

This small steady deflection produced by holding down the key in either of the two cases tried in Experiment 9 was more plainly visible when the mirror was in circuit with the Rye Beach cable, which, besides its shorter length, had no condenser in circuit at the distant station. To obtain some quantitative information regarding the strength of current represented, the fourteen cells were connected in series and more careful observations made.

Experiment 11. See fig. 10.

Closing the circuit formed by the fourteen cells, the six mile earth and Irish sheathing, measurements were made of the steady deflection so produced on the mirror joined up with the Rye Beach cable and sheathing.

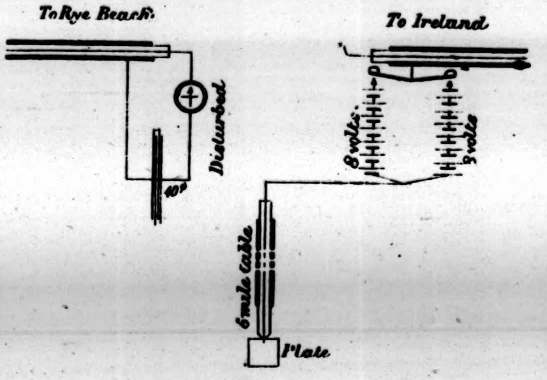


FIG. 8.

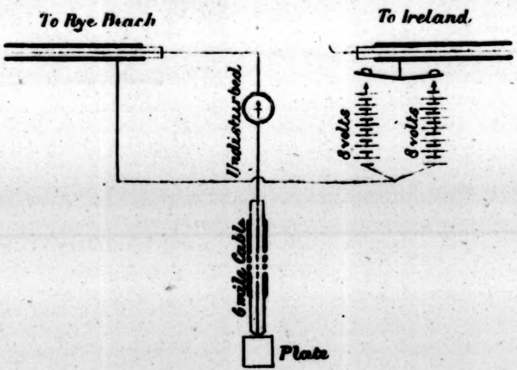


FIG. 9.

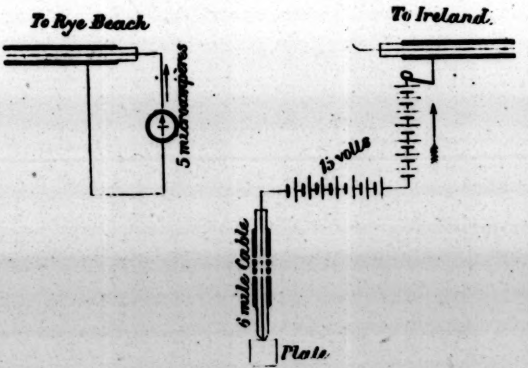


FIG. 10.

The deflection obtained was subsequently found to approximately represent the two-hundred-thousandth part of an ampère—*i.e.*, 5 micro-ampères—and its direction was observed to be that indicating a current entering the Rye Beach cable from that pole of the battery which was connected to the Irish sheathing, reversing when the battery was reversed. Thus, in the figure the copper pole of the battery being shown connected to the sheathing, the deflection represented a current from the copper pole entering the Rye Beach cable through the mirror.

Experiment 12. See fig. 11.

The Irish sheathing was replaced in the battery circuit by the water-pipe earth connection at the office through the trenched cable. On depressing the key the mirror showed the same permanent degree of disturbance as before, in each cable circuit.

Experiment 13.

This experiment was a repetition of No. 3, with the condenser removed. It was subsequently observed in this case that the disturbance was not permanent during the depression of the battery key, but consisted of a small vibration of the spot at the opening and the closing of the battery circuit.

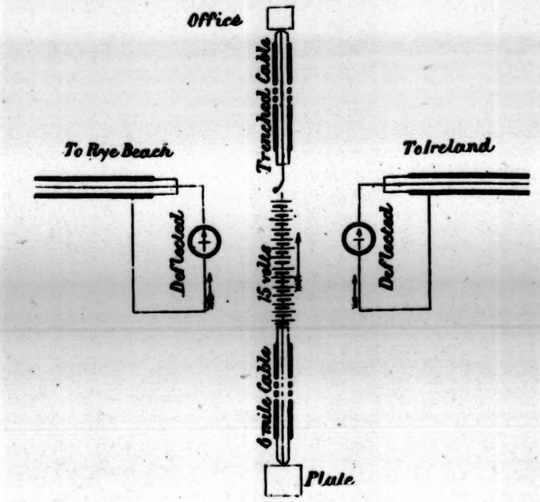


FIG. 11.

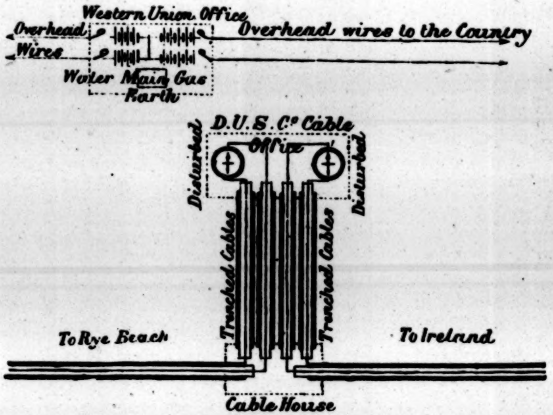


FIG. 12.

Experiment 14. See fig. 12.

This was carried out at the office, situated in the principal street of the town, and nearly opposite to the Western Union Telegraph Office, 50 yards distant. All the Western Union wires are overhead, and the earth connections made for them are the gas and water mains, which, with the telephone lines, form the only metallic connection between the two buildings. With the courteous assistance of the Western Union officials it was arranged that at a given word by telephone several of their circuits should suddenly be operated, and again, all stopped.

When this was done the effect was distinctly visible upon a mirror in circuit with each cable, the disturbance being greater on the Rye Beach line, the earth connections being the cable sheathings through the insulated cables in the trench. Only four known causes could under any conditions produce interference between the two cable circuits, these being, of course, electrostatic induction, electro-magnetic induction, leakage, or bad earth connection in common; and, in the absence of evidence, any one or more might produce it, although no reason could be demanded for the operation of any, since cables lie in other parts of the world for greater distances at equal proximity without the least visible interference.

Experiment No. 10, together with the preliminary trials with the trenched cables, showed that the causes were not to be traced locally to these or to the apparatus; and the high insulation of the cables and circuits, together with the fact that the tests were carried out at the cable house, precluded all possibility of leakage being concerned, so that the operating causes were thus limited to the two forms of induction and bad earth.

The first six experiments did not directly point in favour of any particular cause, but Nos. 7 and 8 rendered the possibility of electro-magnetic disturbance untenable, since the exciting circuit, except in the cable sheathing itself, took a course, as seen on the map, almost at right angles to the two main cables. They further showed that the interference was such as a deficient earth connection would produce. Experiment No. 9 confirmed this view, since no form of induction could set up the steady deflections observed; and leakage being out of the question, bad earth was the only cause that could produce them. It was further necessary to suppose that not only one but both cable sheathings failed to secure good earth, and that the resistance in their respective earth connections was common to both.

Experiment 11 corroborated this position; and No. 12 did more, for it extended the limits of this bad earth region over the whole water pipe area of Halifax, as it would have been impossible to obtain interference under those conditions unless the cable sheathings and the town water pipes formed a common conducting system throughout whose limits imperfect earth connection existed. Finally, the evidence of Experiment 14 followed the same direction, the exciting circuit being in this case the Western Union land lines.

The imputation of bad earth to the gas and water pipe area of a town, and that town a seaport, is sufficiently remarkable; but the presumption of a general earth imperfection in a system of extended water and gas mains, together with the sheathings of three cables running directly into an arm of the sea, may at first sight appear an outrage upon credulity. Due consideration of the experimental evidence renders the conclusion, however, inevitable; and this is tantamount to the assertion that the whole of this system —that is to say, all the land covered by the town, as well as that forming the harbour basin—is composed of substance more or less insulated or insulating.

One of the most interesting features in the geology of Nova Scotia is that the Atlantic seaboard presents an uninterrupted line of Lower Cambrian formation. The relation of this fact to our immediate subject is patent when we remember that these rocks—early in order of geological structure, and said to be almost destitute of organic remains—are here almost entirely composed of argillites, quartzites, and micaceous schists—slates and grits—substances experimentally known to be non-conductors; and according to the published papers of Prof. Honeyman, who has studied the geology of Nova Scotia for many years, no other formations mingle with the Lower Cambrian in the structure of the Halifax basin except the still lower archæan granites, all of which are presumably non-conductors. In fact, the renowned natural advantages of Halifax Harbour are due to the unrelieved presence of these abrupt slaty cliffs that immediately underlie the soil for miles inland.

The question then arises, granting that on the above geological considerations the rocky basin of the harbour and foundation of the city form an insulating crust, or one, at least, interposing a decided amount of resistance between the superficial conducting system and the ocean or earth's mass—is the resistance that can be jointly offered by the three cable sheathings and the whole waterway between the cable house and open sea, of sufficient magnitude to produce the degree of interference observed?

The answer, which seems to be affirmative, strictly demands a computation of the resistance offered by the entire mass of sea water in the harbour under those conditions. This would be a gigantic problem to solve with any pretence to accordance with nature; but for the purposes of the case such limitations may be admitted as shall greatly simplify the calculation.

The map shows that three channels open upon the inner harbour, one running inland through the narrows, and two passing seawards —the eastern passage, and the main or southern entrance. The inland channel terminates in a bay some miles beyond, and may be considered to be practically insulated with the rest of the basin. The waterway in the shallow and narrow eastern passage will evidently offer a comparatively high resistance compared with that of the main entrance, which, therefore demands principal attention.

The general mathematical theory of the earth's resistance is given in Schwendler's "Testing Instructions," following the reasoning of Smaasen's theory, published in 1847. It is shown that if a perfectly conducting small spherical electrode of radius, r, were situated concentrically within a larger hollow perfectly conducting sphere or radius, R, and the intervening space filled with a homogeneous substance of specific resistance, ρ, the resistance of any elementary spherical shell of radius, s, measured from the common centre, would be $\frac{\rho\, d s}{4 \pi s^2}$, and hence the total resistance (ω) between the two spherical electrodes would be the integral of this quantity between the limits $s = R$ and $s = r$

whence

$$\omega = \frac{\rho}{4 \pi}\left(\frac{1}{r} - \frac{1}{R}\right).$$

If the radius, R, of the outer electrode be indefinitely increased, the resulting equation becomes

$$\omega = \frac{\rho}{4 \pi r},$$

which represents the resistance of an unlimited medium of resistance, ρ, to a current passing from a sphere of radius, r, to its ultimate confines. Similarly, a second small spherical electrode of radius, r_1, would offer under the same circumstances a resistance

$$\omega_1 = \frac{\rho}{4 \pi r_1};$$

and if these two small spherical electrodes were placed so far apart in the medium that their direct influence on each other's lines of current flow would be very small, the resistance between them would be

$$\omega + \omega_1 = \frac{\rho}{4 \pi}\left(\frac{1}{r} + \frac{1}{r_1}\right)$$

—a result equivalent to the statement that almost all the lines of current flow issuing from the surface of each electrode would unite with least opposition at indefinitely great distances, and after indefinite diffusion throughout the medium.

If the system were then symmetrically divided by an unlimited insulating plane, the resistance (Ω) between the hemispheres on one side of the plane would be double the above, or

$$\Omega = \rho\left(\frac{1}{c} + \frac{1}{c_1}\right),$$

where c and c_1 are the circumferences of the two hemispheres.

This would then be the resistance between two hemispherical electrodes imbedded in the bounding plane surface of an indefinitely extending homogeneous medium; and if the electrodes were not hemispheres, but vertical plates imbedding active surfaces (s and s_1), the above formula would approximately apply, if c and c_1 be the circumferences of equivalent hemispheres exposing those areas respectively, and the transformed equation would be

$$\Omega = \frac{\rho}{\sqrt{2 \pi}}\left(\frac{1}{\sqrt{s}} + \frac{1}{\sqrt{s_1}}\right)$$

—an equation independent of the distance between the plates.

Similar results are obtained and published by MM. Mascart and Joubert by separate reasoning. The formula applies to the earth's resistance in a telegraphic circuit, on the assumption that our planet has a practical uniform conductivity, and forms practically an indefinitely extended medium.

In the absence of experimental evidence it would be difficult to say how far the variable conductivity of the earth's mass would affect the application of this formula. The conductivity of the material composing the earth's crust probably varies considerably in different localities, and is generally not the same as that of the ocean, for example. It might even be assumed that the resistance of the primary rocks is so great as to limit the conducting area almost entirely to the superincumbent stratified formations.

In that case the earth's telegraphic resistance would be more nearly comparable to the resistance between two small distant electrodes imbedded in the surface of an indefinitely extended sheet of uniform thickness and conductivity. On this supposition, let d be the depth of the earth's conducting crust, assumed to be uniform then the resistance, Ω (*vide* Appendix), between two earth plates of active surfaces (s and s_1) would be, approximately,

$$\Omega = \frac{\rho}{\sqrt{2 \pi}}\left(\frac{1}{\sqrt{s}} + \frac{1}{\sqrt{s_1}}\right) + \frac{\rho}{\pi d} \log._{\epsilon}\left(\frac{4 D}{d}\right).$$

This equation is the same as that of Schwendler last stated, but with the addition of a second term involving D, the distance between the plates; so that on this theory the earth's resistance would increase with the length of the circuit. If submarine cables were sufficiently well insulated, it would be possible to ascertain which of these two theories is nearer to the truth, by measuring the conductor resistances of cables which are laid in duplicate or triplicate between two stations; the difference between the resistance of any pair looped, and the sum of their separate resistances employing the earth circuit, giving, of course, double the earth's resistance between the terminals. It is, however, impossible to decide from present experimental evidence in this way, since not only does the difficulty of accurately measuring these quantities probably increase with the square of the length of cable, owing to leakage and other causes, but also because this second term of the last equation whose existence is in question must in all cases be very small.

Generally speaking, therefore, the experimental evidence may be said to establish the results given by Schwendler's formula, namely, that when the earth plates are separated by any distance great compared with their dimensions, the resistance varies with their active area, and is independent of their distance.

Schwendler gives an estimated superior limit of the specific resistance of the earth in India as 3,300 ω, or about 100 times that of saturated zinc sulphate solution at 10° C.

Returning to the resistance offered by the waterway in the main entrance of Halifax Harbour, we may suppose a current to be flowing seawards through it and the cable sheathings from the cable house. The lines of flow will permeate its whole area, and the equipotential surfaces may be supposed to form across it in successive curves. These surfaces will be practically vertical, and a position has to be assumed for the ultimate one representing the zero potential, or the surface that may be considered to mark the limit of perfect earth connection. Theoretically, of course, this limit would be far out in the ocean; but it may be arbitrarily assumed that a vertical plane shown on the map* by a dotted line connecting the Thrumcap with the Mars Rock buoy represents this boundary, and that the resistance to earth of the ocean mass outside this plane is altogether negligible. The two other dotted lines converging from this base up to the cable house—one skirting Sandwich Point, and the other running over Maugher

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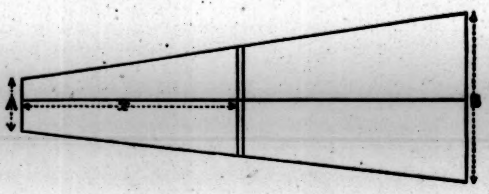
[We have not thought it necessary to reproduce this map.—EDS. ELEC. REV.]

Beach—are intended to represent what may be considered the simple boundaries of an equivalent waterway equal in conductivity to the actual one. The average depth may be taken as 14 fathoms. We have, on this supposition, a mass of sea water resembling a wedge with a blunt point, the breadth of the base being 1·2 knots; the breadth at the apex, say, 5 metres; the length, measured perpendicularly to the base, 4 knots; and the depth, 14 fathoms. Strictly speaking, the equipotential surfaces of flow will be curves convex to the ocean; but the error introduced will not be great if we consider them as planes parallel to the base, or zero surface. Since the fall of potential will take place with equal rapidity through the water and through the sheathings, the resistance of the latter may be taken into account later and independently. The resistance of any



elementary lamina of thickness, $d x$, distant x from the cable house, will be $\frac{\rho\, d x}{h\,(a x + b)}$, where ρ is the specific resistance of the water, h the depth, while a and b are constants; so that the total resistance between the two ends is

$$R = \frac{\rho}{a h} \log._{\epsilon} \frac{B}{A},$$

where B and A are the breadths at the base and apex.

In this case

$$a = \frac{1{\cdot}2}{4{\cdot}0} = 0{\cdot}3;$$

$$h = 14 \times 6 \times 30{\cdot}5 = 2{,}560;$$

$$\frac{B}{A} = \frac{185{,}000 \times 4{\cdot}2}{500} = 1{,}550;$$

$$\rho = 31.$$

The specific resistance of a saline solution of density 1·027 has been observed experimentally to be about 31 ω at 5° C.

With these data,

$$R = \frac{31 \times 2{\cdot}72 \times 3{\cdot}19}{0{\cdot}3 \times 2{,}560}$$

$$= 0{\cdot}35\ \omega,$$

about one-third of an ohm, equivalent to a conductivity of	2·9 mhos.
Compared with this, the conductivity of the eastern passage channel may be estimated at about one-fourth, or	0 7 mho.
The conductivity of the two cable sheathings, each consisting of ten No. 6 wires, and length 4·2 knots, would be 20 × 0·020	= 0·4 mho.
And, finally, the conductivity of 7 knots of cable sheathing in the eastern passage, 10 × 0·012	= 0·1 mho.
Total conductivity	4·1 mhos.

equivalent to a joint resistancee of 0·24 ω. So that if the above reckoning is sufficiently fair, the resistance between the cable house and the ocean is about a quarter of an ohm.

The resistance actually offered can be estimated from the data of Experiment 11, as follows:—

The E.M.F. in the exciting circuit was about 15 volts; the resistance, 66 ω in the cable and earths, and 24 in the battery—total, 90 ω. In the Rye Beach circuit the resistances at the time were, approximately—

Observing mirror...	2,000 ω
Cable conductor	5,800
Relay at Rye Beach	1,000
Total	8,800 ω

Since the interference current observed in this circuit was, as already mentioned, 5×10^{-6} ampères, the E.M.F. impressed upon the cable due to interference was

$$5 \times 10^{-6} \times 8{\cdot}8 \times 10^{3} = 0{\cdot}044 \text{ volts};$$

and consequently, if x be the required resistance of the general earth connection,

$$x : 90 :: 0{\cdot}044 : 15,$$

or

$$x = 0{\cdot}26\ \omega,$$

or an actual resistance of a quarter of an ohm. The agreement between the actual and measured values is really much closer than the accuracy of either determination would warrant.

The only experimental results still left unaccounted for are those of Nos. 3, 4, 5, and 6, in all of which the six-mile earth was used either in the exciting or observing circuit; and since Experiment 13 proved that this earth plate was outside the limits of the semi-insulated basin, as might be expected from its position on the map, it would be impossible to account for the interference in those cases on the score of a common imperfect earth. Reflection shows, however, that the interference observed would be an indirect necessary consequence of the imperfect earth, since the six-mile earth, when connected to either main circuit, forms a cable loop of, say, 10 knots within the limits of the semi-insulated basin, and a slight variation in the potential of the basin is calculated to produce a considerable electrostatic effect on the cable. It has, in fact, been found experimentally that when 1,000 feet of insulated cable core (of similar capacity to that of the cables at Halifax) are coiled in an insulated tank and left in communication with the earth through a mirror instrument, the electrostatic disturbance of the mirror is about equal to that observed in these experiments (3—6) when the potential of the tank is altered by 0·2 volts. The total charge passing through the mirror in Experiments 3 and 6 would be the resultant effect of the whole system of harbour potential variation on the four knots of cable under observation, except in so far as the capacity of the cable seawards would modify the influence. In Experiments 4 and 5 the interference would, on the other hand, be due to electrostatic charge entering the observing circuit owing to the variation in the harbour potential, electrostatically produced by the loop of exciting cable traversing it. An external average variation of 0·01 volt in the potential of the basin would suffice to account for the degree of interference observed; and this amount of variation, it is evident, the conditions amply supply. Experiment 13, contrasted with Nos. 9 and 11, showed that the interference observed in cases 3, 4, 5, and 6 was of an electrostatic nature.

The sensitiveness of a cable to external electrostatic influence can be shown experimentally by joining up a mirror galvanometer in circuit with 100 miles of cable and earth. If the distant end be sealed, and laid for two or three feet in an insulated joint trough filled with water, the potential of which is capable of being varied suddenly through 100 volts (from + 50 to − 50), the effect is immediately visible on the galvanometer; and in fact, simple signals have been transmitted in this way from ship to shore through the coatings of a joint.

The hypothesis of an insulated or semi-insulated basin, therefore, satisfactorily explains all the phenomena observed. It accounts, first, for the meteorological disturbances which are observed on the cables, since any alteration of the charge or position of electrified clouds in the vicinity of the harbour may affect the distribution of charge in the cable to an extent that would not be possible if the harbour were in more perfect electrical communication with the ocean or earth's mass; and all the phenomena experimentally observed can be traced either to the direct or indirect effects of this imperfect earth connection—directly by conduction, indirectly by induction.

Assuming, then, that the Lower Cambrian rocks effectively insulate the Halifax basin, it is necessary to suppose that the same effect would be produced at any landing place on the Atlantic shore of Nova Scotia, where these rocks so generally prevail. This is also corroborated by the fact that previously at Torbay some difficulty of the same kind appeared when attempts were originally made to utilise an ordinary earth connection for an overhead Morse circuit. The interference with the cables thus set up rendered a special earth necessary for the land line in the bay. The fact that no interference was visible between the cables themselves is accounted for by the open landing place and absence of any such basin as Halifax Harbour presents.

In Mr. James Graves's paper on earth vibrations, already alluded to, mention is made of the slaty character of the rock in the neighbourhood of the station, and so favours the supposition that the interference there observed was due to the same causes.

It is stated that in the Lake Superior region of the United Sates great difficulty has occasionally been found in obtaining efficient earth, even when no local cause for the deficiency has been apparent. I am indebted to Professor Moses G. Farmer for the facts of a case which came under his own notice, where an earth connection, apparently good and well situated, was found useless, and measurement showed that its resistance to earth was 12,000 ω. I also owe to him the information that interference, due to imperfect earth, was found in 1869 at St. Pierre Miquelon, the Morse signals on the St. Pierre Placentia circuit affecting the Atlantic cable to Brest, and that special measures had to be taken to effect a better earth connection.

Generalising from these facts, it would seem that there may be difficulty in obtaining good earth at cable stations opened on a shore of primary or metamorphic rock, and that permanent interference beyond remedy by earth connection is possible between cables landed in a basin of such formation; so that if this statement receive confirmation at the hands of the members of this Institution, it will be evident that a due regard will be given to geological conditions by electrical engineers among the many incidental considerations that determine their selection of a cable's landing place.

APPENDIX.

"On the resistance between two electrodes of active surface (s and s_1) imbedded in the surface of an indefinitely extended homogeneous medium of specific resistance, σ, comprised between two unlimited parallel planes separated by a perpendicular distance, d, the distance between the electrodes being represented by D."

Let r and r_1 be the radii of the equivalent hemispheres exposing surfaces of s and s_1 respectively. Then, if an infinitely thin perfectly conducting hemispherical shell of radius, d, concentrically surrounds each of these electrodes, these shells will touch the opposite bounding plane of the medium, and the resistance between them and their included electrodes will be

$$\frac{\rho}{2\pi}\left(\frac{1}{r}-\frac{1}{d}\right) \text{ and } \frac{\rho}{2\pi}\left(\frac{1}{r_1}-\frac{1}{d}\right) \text{ respectively.}$$

If D be large compared with d, these two shells may be approximately considered as two parallel cylinders of radius $\frac{d}{2}$ traversing the medium at right angles to the bounding planes, and their surface potentials may be written*—

$$v_1 = \text{constant} - \frac{c\rho}{2\pi d}\log_{\epsilon}\left(\frac{\frac{d}{2}}{D}\right);$$

$$v_2 = \text{constant} - \frac{c\rho}{2\pi d}\log_{\epsilon}\left(\frac{D}{\frac{d}{2}}\right),$$

where v_1 and v_2 are the potentials and c the strength of current.

$$\therefore v_1 - v_2 = \frac{c}{2\pi d}\left(\log.\frac{2D}{d} - \frac{\log. d}{2D}\right),$$

$$\therefore \text{Resistance} = \frac{\rho}{\pi d}\log_{\epsilon}\left(\frac{4D}{d}\right);$$

so that the total resistance,

$$\Omega = \frac{\rho}{2\pi}\left(\frac{1}{r}+\frac{1}{r_1}-\frac{2}{d}\right)+\frac{\rho}{\pi d}\log_{\epsilon}\left(\frac{4D}{D}\right);$$

and since d is large,

$$\Omega = \frac{\rho}{\sqrt{2\pi}}\left(\frac{1}{\sqrt{s}}+\frac{1}{\sqrt{s_1}}\right)+\frac{\rho}{\pi d}\log_{\epsilon}\left(\frac{4D}{d}\right),$$

approximately.

Physical Society.

The annual general meeting of this society was held on February 9th, Prof. Reinold, President, in the chair. The following gentlemen were elected to form the New Council: *President*—Prof. A. W. Reinold, M.A., F.R.S. *Vice-Presidents*—Dr. E. Atkinson, Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, M.A., LL.D., F.R.S., The Right Hon. Lord Rayleigh, M.A., D.C.L., Sec. R.S. *Secretaries*—Walter Baily, M.A., Prof. J. Perry, F.R.S. *Treasurer*—Prof. A. W. Rücker, M.A., F.R.S. *Demonstrator*—C. Vernon Boys, F.R.S. *Other Members of Council*—Hon. R. Abercromby, T. H. Blakesley, M.A., M.I.C.E., W. H. Coffin, Conrad W. Cooke, Prof. O. Lodge, D.Sc., F.R.S., Prof. W. Ramsay, Ph.D., F.R.S., W. N. Shaw, M.A., Prof. S. P. Thompson, D.Sc., H. Tomlinson, B.A., G. M. Whipple, D.Sc. The meeting was then resolved into an ordinary science meeting, at which a paper on "Physico-Geometrical Models," was read by Prof. A. S. Herschel, D.C.L., F.R.S.

NEW PATENTS—1889.

1856. "Improvements in the method of and means for the regulation of dynamos." J. H. Woodward and E. S. G. Rees. Dated February 4.

1961. "Improvements in microphone apparatus for increasing and transmitting sounds by means of earth currents, also by means of chemical batteries." R. H. Courtenay. Dated February 4.

2003. "Improvements in electric-regulating apparatus for use in connection with steam engines and other motors and dynamo-electric machines." A. L. Shephard. Dated February 4.

2006. "Improvements in apparatus for receiving payments and permitting the administration of electricity in exchange therefor." H. H. Lake. (Communicated by D. R. Johnston, Belgium.) Dated February 4.

2044. "An improved type writer and telegraphic apparatus, applicable in combination therewith." C. H. W. Stielow. Dated February 5.

2066. "Improvements in the manufacture of electrodes for secondary batteries or accumulators." L. Paget. Dated February 5. (*Complete.*)

2079. "An improvement in plates for secondary voltaic batteries." A. H. Norman. Dated February 5.

2080. "Improvements in and relating to portable electric batteries and in electrodes therefor." H. H. Lake. (Communicated by L. T. Stanley, United States.) Dated February 5. (*Complete.*)

2082. "Improvements in or relating to telephone call boxes." W. P. Thompson (Communicated by A. Griffith, H. A. Burbank, and W. H. Jordan, United States.) Dated February 5.

2141. "An electric meter." C. Baur. Dated February 6.

2145. "An improved electrical apparatus for lighting cigars or pipes, and for other purposes." W. Green. Dated February 6.

2151. "Improvements relating to electric batteries." W. J. Woodward and F. H. Judson. Dated February 6.

2168. "Improvements in or appertaining to electric metres." W. P. Thompson. (Communicated by H. O. Tudor, Grand Duchy of Luxemburg.) Dated February 7.

2169. "Improvements in or relating to electric signalling apparatus for railways." W. P. Thompson. (Communicated by E. J. J. de Baillehache, France.) Dated February 7.

2176. "Improvements in materials and methods of preparing the same for bases of electrical instruments and for other electrical purposes." F. L. Rawson. Dated February 7.

2205. "China or porcelain cap or socket for incandescent electric lamps." E. W. Lancaster. Dated February 7.

2206. "Improvements in the electro-deposition of metals, specially applicable for depositing on fragile articles or coating, plating on, or forming articles of irregular surface." T. P. C. Crampton, E. G. Colton, and The Medical and Scientific Apparatus Company, Limited. Dated February 7.

2243. "Electrical connections attached to railway locomotives, and to connect to a metal plate affixed near the rail, arranged by a metal wire brush." W. Andrews. Dated February 8.

2252. "The improvement of instruments for measuring currents of electricity." J. W. King. Dated February 8.

2276. "Improvements in the construction and arrangement of primary batteries." E. Guitton. (Communicated by M. Sappey, France.) Dated February 8. (*Complete.*)

2297. "Improvements in primary and secondary transportable galvanic dry elements." C. Smith. (Communicated by W. L. F. Hellesen, Denmark.) Dated February 8.

2299. "Improvements in apparatus for measuring electric currents." L. A. W. Desruelles and R. F. O. Chauvin. Dated February 8.

2313. "Improvements in means of applying electricity for therapeutic purposes." H. N. Lawrence. Dated February 9.

2349. "Improvements in and relating to electric appliances for illuminating the dials of clocks and watches." T. H. White. Dated February 9.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

981. "Improvements in electric call signal apparatus." C. Spratt. Dated January 21. 11d. Consists of a combined step by step transmitter and receiver. The claims are 3 in number.

12063. "Improvements in or relating to electrical type-writers capable of being used as printing telegraphs." A. J. Boult. (A communication from J. F. McLaughlin of Philadelphia.) Dated August 21. 11d. Relates to an electrical type-writer capable of being used either as an independent electro-mechanical instrument, or as a receiver in conjunction with a suitable transmitter for printing telegraphs. In this latter instance, the instrument described is more particularly designed to be utilised in conjunction with the transmitter which is the subject matter of Letters Patent No. 7,202, dated the 17th of May, 1887. The claims are 18 in number.

12064. "Improvements in or relating to electrical type-writers capable of being used as printing telegraphs." A. J. Boult. (A communication from J. F. McLaughlin, of Philadelphia.) Dated August 21. 11d. Relates to an electrical type-writer capable of being used either as an independent electro-mechanical instrument or as a combined transmitter and receiver for printing telegraphs. The claims are 10 in number.

12065. "Improvements in or relating to electrical type-writers capable of being used as printing telegraphs." A. J. Boult. (A communication from J. F. McLaughlin, of Philadelphia.) Dated August 21. 8d. Has reference to improvements in electrical type-writers, each of which is adapted for use both as a transmitter and receiver if connected with a similar instrument located at a different station, and as an independent local instrument when not connected with a line, and relates to improvements in the construction of the more essential parts of the apparatus, whereby the functions of the same are performed with greater ease and certainty; the mechanical difficulties of construction inherent in the original form are obviated, and the cost of the type-writer is reduced. The claims are 8 in number.

12453. "Improvements in apparatus for hardening and tempering by electricity." W. P. Thompson. (A communication from abroad by P. Diehl, of America.) Dated August 29. 8d. Claims:—1. An apparatus for hardening or tempering, consisting of the combination of a chute or conveyer, a feeder delivering the articles to be hardened or tempered thereto, a source of electric currents having its circuit through the chute or conveyer, whereby the latter is heated, an agitator or vibrator moving the conveyer and causing the articles to pass through the same, and a vessel for containing the cooling bath into which the articles may be delivered from the chute. 2. In an apparatus for hardening or tempering, the combination with a chute or conveyer through which the articles to be operated upon may be passed, and a source of electricity having its respective poles connected with different points in the length of said chute or conveyer. 3. In an apparatus for hardening or tempering needles and similar articles, the combination of a heating chute or conveyer, a source of electric currents having its circuit through said conveyer, and a vibrater applied to the chute, substantially as described.

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* See Mascart and Joubert's "Electricity and Magnetism," vol. i., p. 205.

13598. "Improvements in electric motors." R. R. Hutchinson. Dated September 20. 8d. Consists chiefly in forming the poles of stampings, or pressed pieces of soft iron, suitably curved to coincide with the circular form of the armature, and in forming the core of the field magnets of stampings or pressed pieces, placed vertically on both sides of the poles, and alternately between the stampings, and held in position by means of transverse studs and nuts. The claims are 4 in number.

14492. "Improvements in electrical signalling, indicating, or registering apparatus for railway purposes." J. B. Sutherland. Dated October 9. 8d. Consists in a novel construction of a track instrument and devices connected therewith by means of which the number of cars in each train passing over certain sections of railroad can be automatically and positively signalled or registered. The claims are 7 in number.

14691. "Improvements in telephone central-station apparatus." (Under International Convention.) T. N. Vail and J. A. Seely. Dated April 20. 8d. Claims:—1. The combination of a central station, a series of sub-stations, a series of metallic circuits, one for each sub-station, connected in parallel at said central station, a telephone instrument for each circuit at the sub-station, a receiving telephone at the central station in a local circuit having fixed electrical contacts, two separable contacts for each metallic circuit, and a suitable device for separately connecting and disconnecting the two terminals of each metallic circuit with the terminals of the local circuit, substantially as described. 2. The combination of a series of sub-stations, a central station, a series of metallic circuits, one for each sub-station, a telephone instrument for each circuit at the sub-station, a receiving telephone at the central station, a local circuit having fixed electrical contacts in which the receiving telephone is permanently located, a flexible cord forming the terminal of each circuit, and a double-contact switch-plug for each cord having electrical contacts registering with the fixed contacts of the local circuit and normally resting thereon, whereby all circuits are connected in parallel with the receiving telephone, and any circuit may be connected and disconnected therewith independently, substantially as described.

14980. "Improved method of and apparatus for operating capstans, windlasses, hoists, and the like by means of electricity." R. R. Hutchinson. Dated October 18. 6d. Claims:—1. The combination of a vertical capstan with an electric motor and gearing for actuating the same, substantially as described and shown by drawings. 2. The construction of a windlass, crab, or hoist provided with a horizontal barrel or barrels, with an electric motor for actuating the same, with simple or compound gearing, and with or without an electrical or mechanical brake, substantially as described and set forth. 3. The combination of an electrical motor with a vertical or horizontal barrel or barrels, or capstans, for the purpose of rotating same, and with or without the electrical brake forming the subject of the specification of patent No. 14,979, 1888, substantially as described and set forth.

CORRESPONDENCE.

Hooper's Core.

My attention has been called to your review of a work lately published in France, edited by Mr. E. Wünschendorff, and in your criticism of the work you infer that a decree of "Anathema Maranatha" was declared against Hooper's Core after the laying of the cables for the Western and Brazilian Telegraph Company.

"Anathema." I do not dispute that the failure of some of the cable submerged on the Brazilian coast to maintain communication has in certain quarters been attributed to the core in those cables.

The fact is, however, that these cables, originally designed to cross the Atlantic, were diverted to the Brazilian coast, and laid in depths and on such a bottom as were for the most part totally unsuited to the deep sea type of cable.

The managing director of the Western and Brazilian Telegraph Company has certified that he has every reason to believe that any interruptions which h
occurred have been occasioned by external injuri
that they were due to no defect in the core itself,
which he has every reason to be fully satisfied, and
cable as was laid in deep water has continued to the
sent time to work without interruption.

Moreover, a portion of the deep sea cable refer
to, which was manufactured for the Great We
Telegraph Company, and transferred to the We
and Brazilian Telegraph Company, was laid eight y
ago for the Cuba Submarine Telegraph Company
connect Santiago de Cuba with Cienfuegos, and
continued in good working order ever since, with
repair being required.

The cable laid by us between the same points in 18
has worked without interruption, with the exception
the renewal of the shore ends.

The cables owned by the Great Northern Telegr
Company, containing Hooper's core, have
deteriorated so far as the core is concerned, tho
some are now twenty years old.

The Persian Gulf cable, laid in 1869, continues
work well, and some pieces of core sent home show
core to be as perfect as when it left the factory.

"Maranatha." Time has shown that in no case h
a submarine cable core manufactured by Hoopers faile
through deterioration of the core.

I ask your kind indulgence to allow this expla
tion to appear in your widely-circulated journal.

Jno. B. Hooper.

Alkaline Accumulators

Will you kindly permit me to remind your readers
a small contribution to the subject of alkaline accum
lators from a voltage point of view, which I publis
in the *Philosophical Magazine* for January, 1870,
of which I beg to enclose a copy?

J. Parnell.

February 14*th*, 1889.

[We have much pleasure in reproducing Mr. Parnell
paper of 20 years ago in our other columns, for it is
a highly interesting character.—Eds. Elec. Rev.]

Analogies.

In your last issue Mr. G. H. Bays, Junr., in a lett
dated January 12th (?) finds fault with my analog
and reasoning from his point of view. I quite admit i
shortcomings, but my object in using it was to lay str
on these "more or less *unavoidable* points," and sh
that they *could* be avoided; giving increased permane
and greater "Insulation Resistance." Perhaps I mig
with advantage have omitted the last part of t
sentence. In your description of the method I propo
you will notice a printer's error, "and if the block
fitted with porcelain fuse plates," you meant to re
"and if the block be porcelain, fitted with fuse plat
&c.

Fred Bathurst.

February 19*th*, 1889.

Jacob's Improved Duplex.

I don't think there is need for me to take up yo
space or your time by an answer to Mr. Bark
difficulties in your issue of 8th inst. as his own diagr
shows the necessity of introducing into the dup
system the analogue of the U.G. return earth cab
If the "earth tails" were joined together, as they
in the artificial cable branch, the symmetry of the t
branches of the bridge would be complete. It
hardly necessary to remind Mr. Barker that the brid
system includes the whole circuit between
terminals of the signalling key.

F. Jacob.

February 19*th*, 1889.